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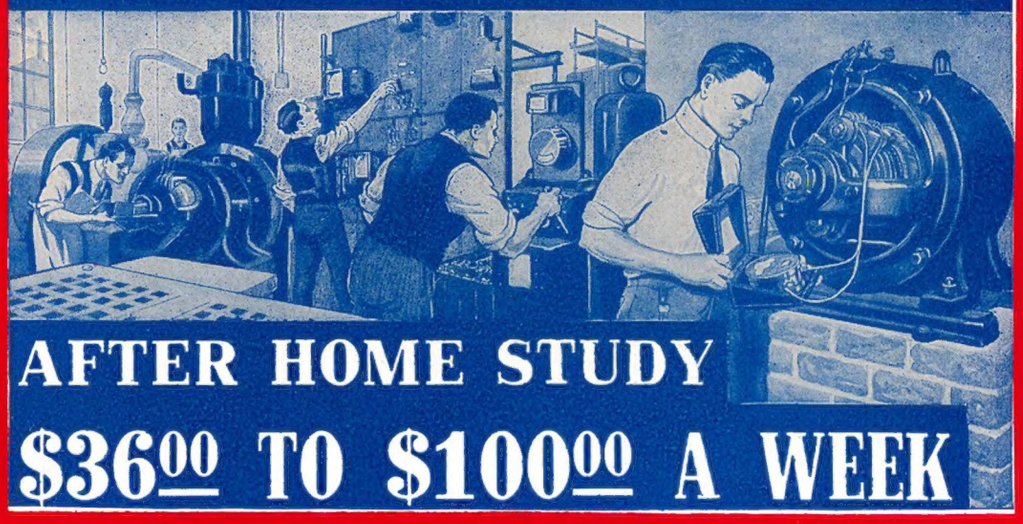

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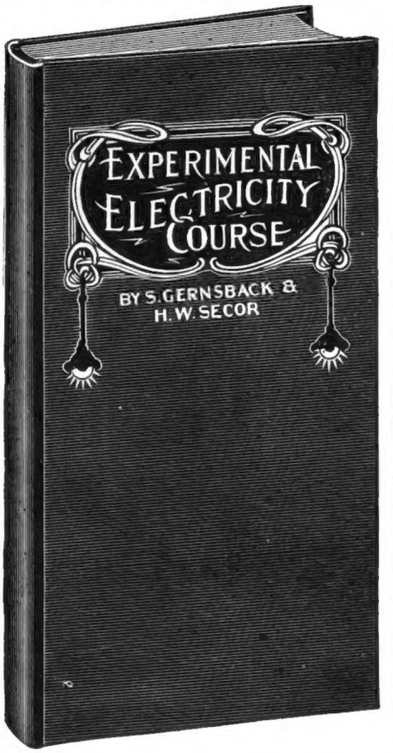

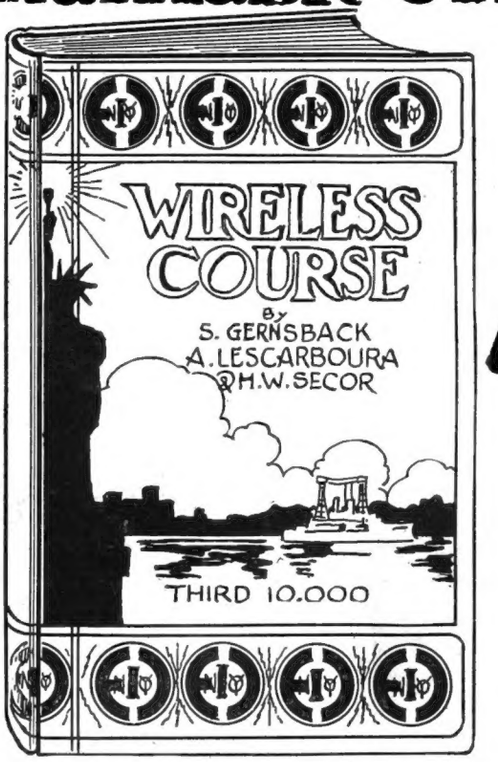

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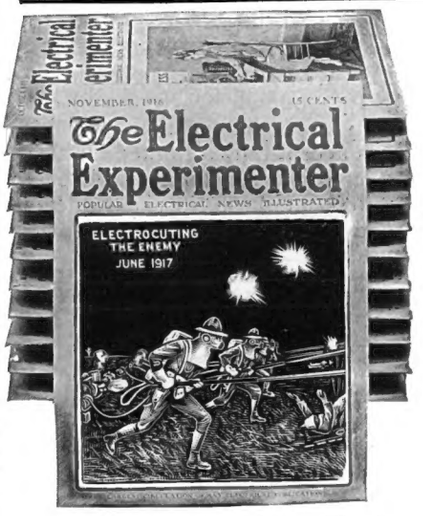

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War and the Inventor

IN this great crisis, a word to our patriotic inventors will not be amiss. As I have pointed out before, the average inventor is a poor business man and a worse salesman. No matter how clever or how ingenious he is, he will insist upon presenting his story in the worst possible manner. As a rule he has labored for nights upon nights in solving an important problem; every phase of the invention is so clear and lucid to him that he becomes irritable and angry if those about him do not at once grasp all the details. Or else, in his enthusiasm, he will sit down and taking a piece of brown wrapping paper and a pencil, he will forthwith begin to write out a few often unintelligible phrases, garnished with incomprehensible sketches, which are supposed to clearly explain his invention. He closes the missile by offering his device "free and gratis" to the Government, puts it in an envelope addrest to the Secretary of the Navy, and then mails the letter, thinking that he has done a great patriotic act. Then if a long ominous silence follows, the inventor as a rule becomes embittered and hostile to the Government.

Now, this is no exaggeration. As Editor of *"Patent Advice"* I receive from twenty to thirty letters a day, to be transmitted to the Government, if in my estimation the device is practical. And not two of these ideas are submitted in a presentable or even an intelligent manner. Penciled letters prevail and often the sender forgets to sign his name. And in Washington the War and Navy Departments are deluged daily with just this sort of mail, ninety-nine percent of which is discarded. And it probably happens once in a while too, that the Government loses a really good idea simply because the one submitted was unintelligible and in consequence found its grave in a waste basket.

Now the man at his desk in Washington is human—and consequently weak. Try as he may, he will pay more attention to a neatly typed letter, than to a scrawly penciled note. A correctly drawn sketch will at least arouse a passing interest, whereas a misshapen free-hand pencil design, will rarely fetch a spark of enthusiasm.

The inventor would not dream of running to the War Department in armsleeves, unkempt, unshaven and in a soiled and torn shirt. But he insists on sending the child of his brain just that way.

If you have an idea that you think is worthy, this is the way—the only way—to proceed: Remember first, that the Government receives daily thousands of useless letters from inventors—*yours* may be useless, no matter what YOU think. Remember too that there is no greater intoxicant than a newly born invention; under its influence you are in no condition to think straight, least of all sending your invention to Washington. I have been intoxicated myself dozens of times in precisely this manner and I know whereof I speak.

First you should take your plan to a trusted friend who is versed in mechanics or electricity. Invite criticism. Obtain expert opinion. Remember you don't know it all—no one does. Edison says he is just beginning to know a few Nothings.

If the expert advice convinces you, that you really have a worthy device, then and only then begin to think about Washington. Have someone typewrite your idea in a neat and clear manner AND MAKE IT SHORT. Long explanations hurt your cause. Use the telegraphic style, just as if you had to pay for each word and don't attempt to make your own drawing, unless you are thoroly familiar with drafting instruments. Find a draftsman who will make a creditable drawing in China ink upon a bristol board. Then sign your name and address to BOTH description and drawing, and mail the two FLAT. Don't roll either manuscript or drawing. But use a piece of heavy stiff cardboard to keep the contents of your letter from being folded in the mails. If you do this I promise you a warm letter of thanks from the official who reads your invention.

Moreover, don't send your letter to your Congressman or to your Senator, as many misguided inventors are wont to do. At best it only delays it. Instead, address it to either the *Secretary of War,* or to the *Secretary of the Navy,* all depending upon what subject your invention treats. Last but not least don't worry our officials with torpedo or submarine catchers which depend upon magnets. The majority of ideas submitted are based upon this popular delusion. Here are facts: If you had an electromagnet that would attract one million pounds (no such animal was ever built!) a steel torpedo rushing by it at a distance of 20 feet would not be deviated one inch from its course. For the largest electromagnet exerts practically no *tangible* force a few feet away from its poles.

H. GERNSBACK.

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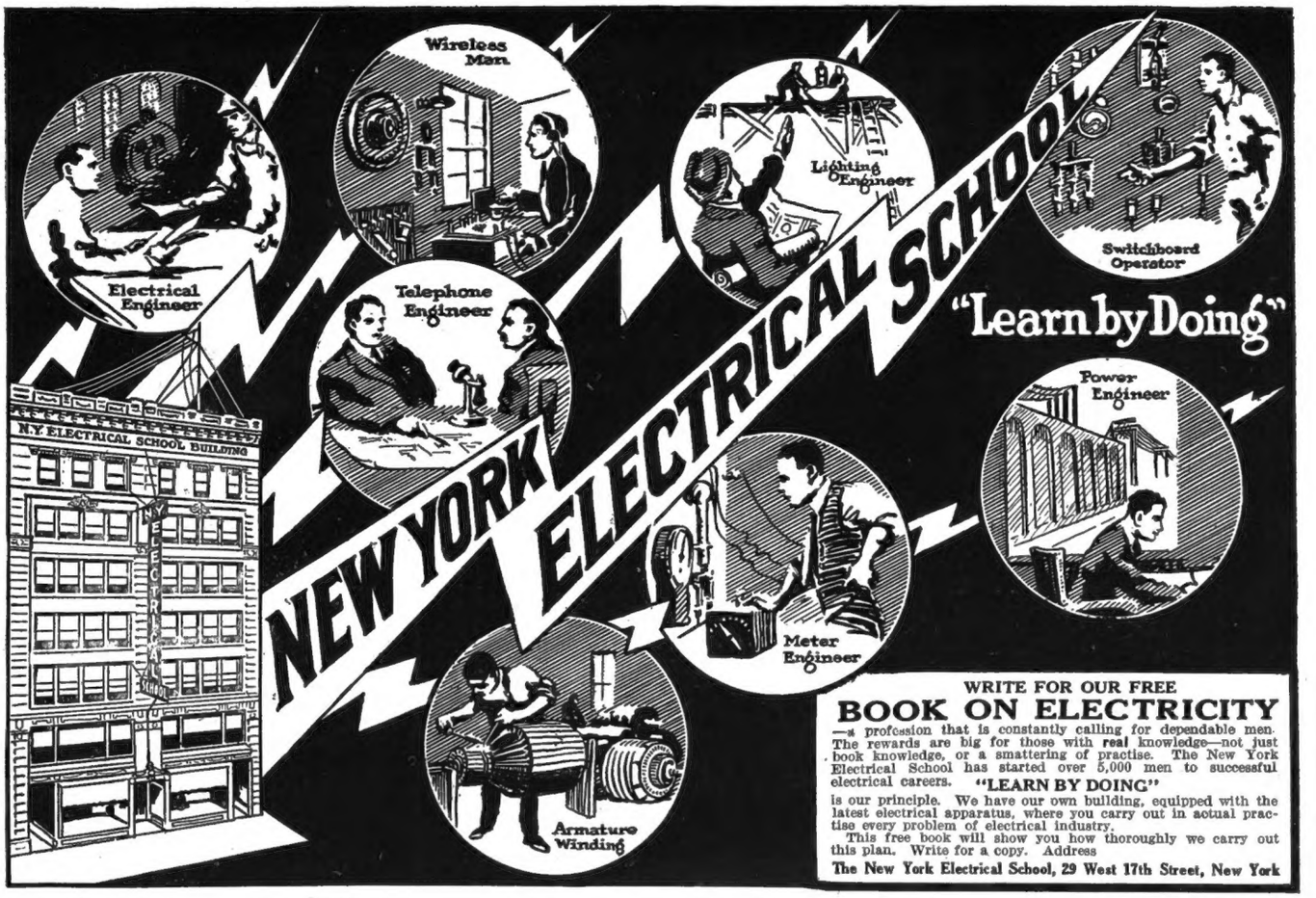

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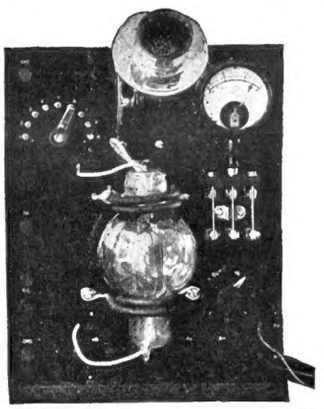

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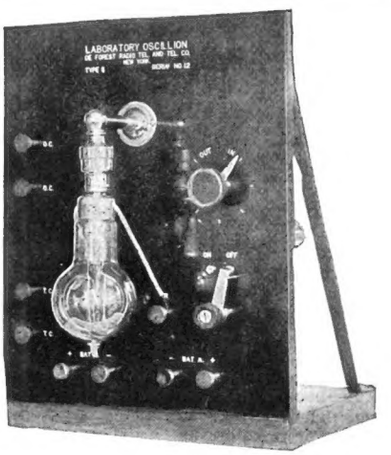

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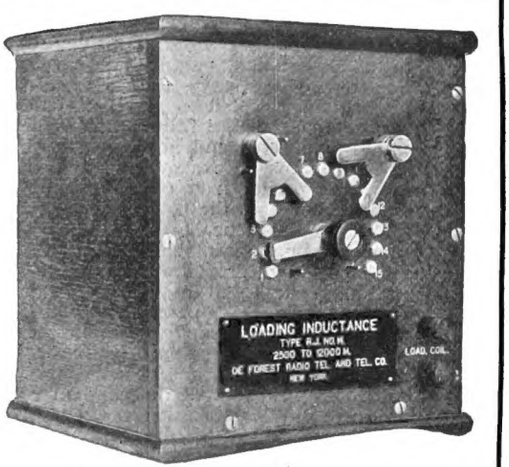

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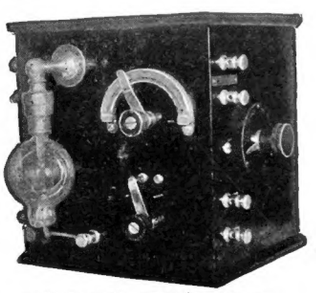

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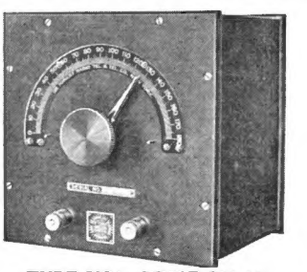

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THE ELECTRICAL EXPERIMENTER

H. GERNSBACK EDITOR
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Vol. V. Whole No. 51 July, 1917 Number 3

Locating and Destroying Submarines with Red Light

A NEW method due to Yankee ingenuity and intended for locating submerged sub-sea boats at a considerable range has recently been worked out. It has been described by a retired naval officer and appears to have made a favorable impression on the navy's experts.

If once it becomes possible to locate the presence of an enemy submarine, then the greatest worry of cargo steamship captains will be over, for when the "sub's" location is spotted then the vessel's guns will be trained on the spot. As soon as the under-water boat comes to the surface to take her sightings she will be met with a hail of shot and shell.

The new method, holding great promise for the destruction of the submarine and its entire elimination as an efficient weapon of warfare is now being perfected, and it is probable that within a very few weeks vessels may navigate the high seas with safety, so far as submarine attacks are concerned.

As may be imagined, the experimenters in this field are not willing to make public the actual experiments, details and results accomplished, but the following outline of the method now under consideration will be of great interest to the public.

Inasmuch as the great advantage of the submarine over surface vessels is the fact that it is hidden from view, if by some means the exact location is made known to a vessel before she approaches within the danger range (2,000 to 2,500 yards) of the submarine, the menaced vessel can invariably escape.

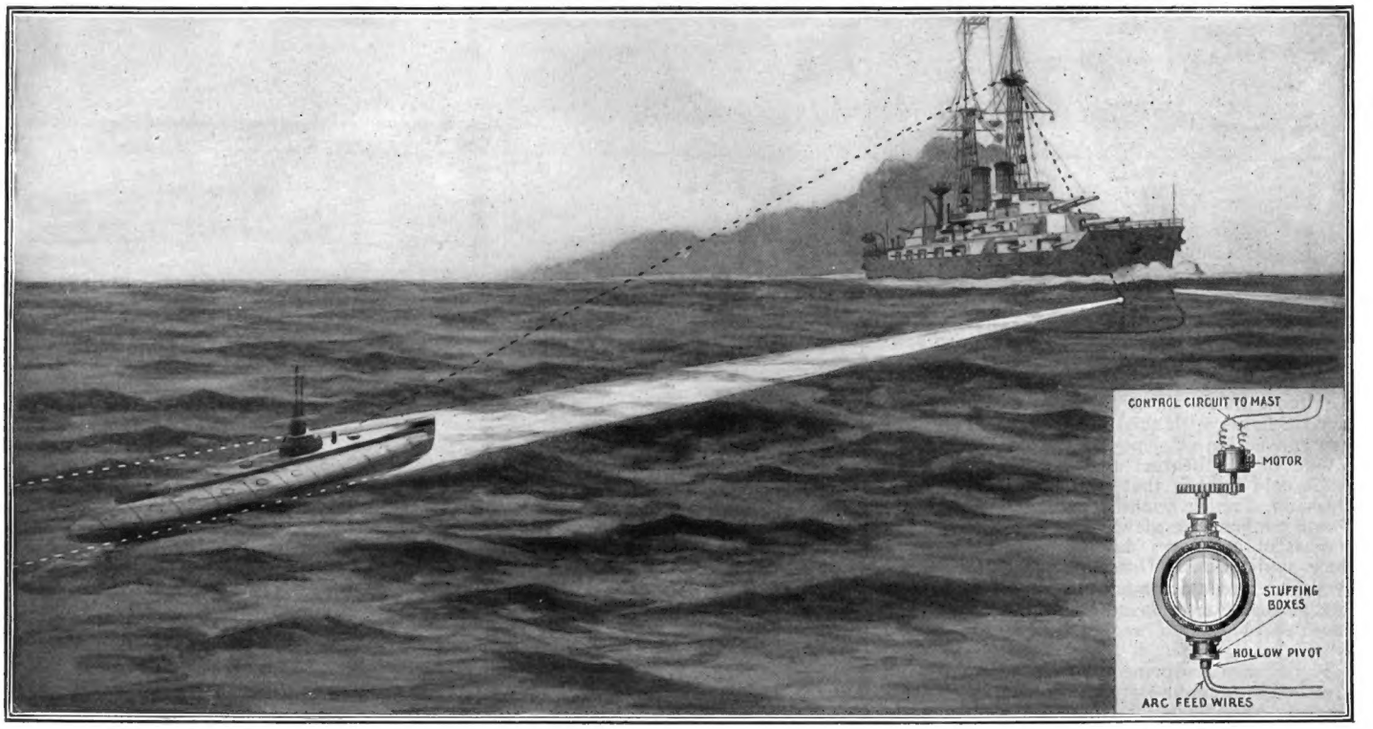
In seeking methods to be employed for certain purposes, inventors and experimenters frequently turn to the five senses when beginning the solution of a baffling problem. We cannot feel, smell or taste a submarine over a mile distant, so we are left only two of the senses remaining—the sense of the eye and that of the ear.

The microphone enables us to hear more or less distinctly the engines of the submarine when they are working at more than slow speed, but this is not sufficient, as a submarine lying in wait to torpedo a vessel needs only to turn her engines over very slowly to maintain her depth below the surface.

A submarine vibrator operated by electricity has produced an echo from an iceberg two miles distant, but it is doubtful if the system can be improved to efficiency in the case of the submarine. Now let us consider our remaining sense: sight.

When our ship approaches the danger zone of the submarine the latter is maintaining a heading which is nearly at

(*Continued on page* 215)

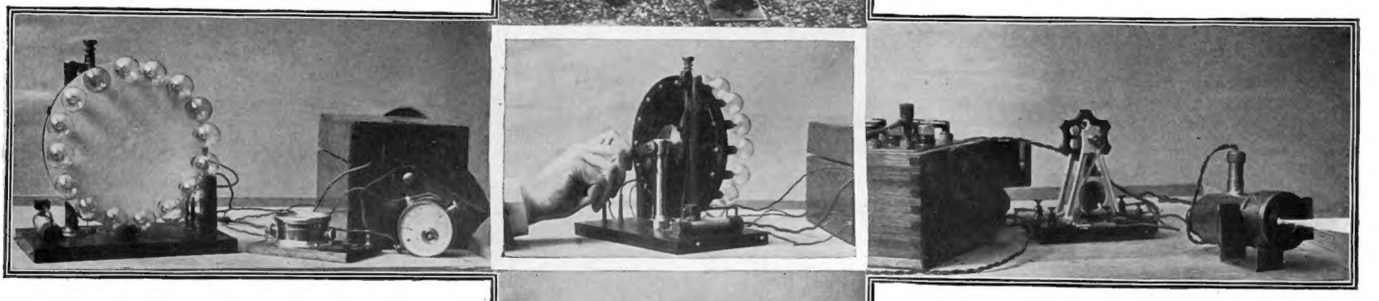


Why Not Locate the Submerged, Yet Always Dangerous, Enemy Submarines by Continually Flashing a Powerful Red Searchlight Beam Back and Forth Thru and Under the Water, Asks a Yankee Genius. Once a "Bulge" Is Spotted (Day or Night) in the Light Beam, the Observer on the Mast Signals That Fact to the Gun Crews. Consequence—as Soon as the Periscope Appears the Already Trained Guns Open Fire. The Spotting Range Is Over Two Miles, Day or Night.

Cold Light

WE are accustomed to seeing the electric or other source of light with unfeeling senses, *i. e.*, without stopping to realize for one moment that—while it is undeniably true that the modern electric light is a masterpiece of scientific attainment, thanks to Edison and other investigators—we are actually paying many times what we should expend for this human comfort. Think for one moment that only *3 per cent* of the electrical energy put into a modern gas-filled, tungsten filament, incandescent electric lamp is realized as *useful light;* the balance of the energy is paid for and uselessly dissipated in the form of heat and other radiation.

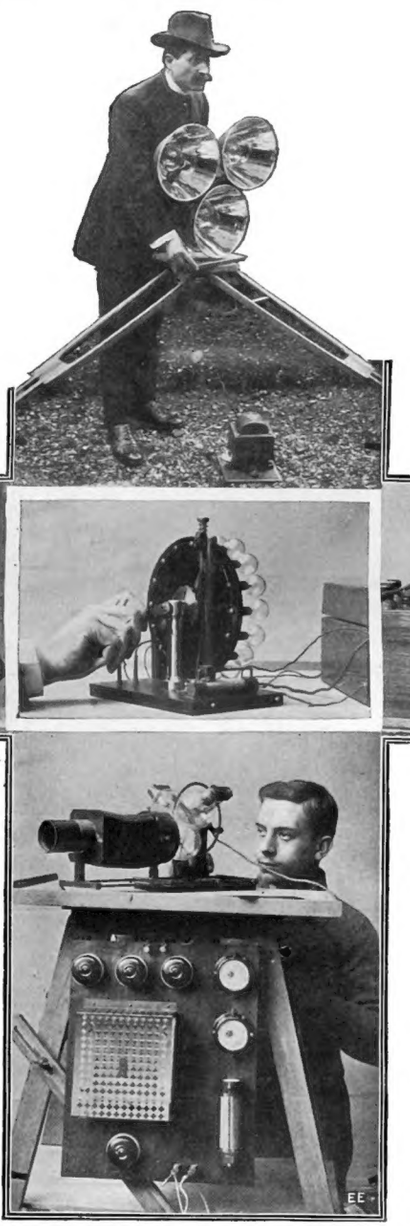
The fire-fly is one of the greatest and absorbing wonders of all Nature. Why?—because he knows how to produce practically a *cold light.* The illumination engineers of today are studying the problem with all the resources at their command. There ought to be—there must be a way in which to convert all or nearly all of the electrical energy into useful light. The electric motor converts electrical energy into mechanical energy with an over-all efficiency of 90 to 98 per cent. Suppose we had perfected an electric motor with an efficiency of but 3 per cent; how many motors do you think there would be in use? Yet we are content, at least until we know more about the subject, to use electric lights with this almost unbelievably low conversion efficiency.



Above — Complete Dussaud Experimental "Cold Light" with Generator and Current Measuring Meters.

One of the nearest approaches to man-made cold light is that of Professor C. F. Dussaud, French scientist and investigator. The accompanying views show some of the successful apparatus devised by him, also their applications. Dussaud has evolved a very ingenious arrangement, which, altho not giving a true *heatless* light, yet produces light with a negligible quantity of heat.

The elementary principle upon which this so-called cold light is based is that of impressing at sufficiently close and intermittent intervals an excess voltage of several times the normal value to each lamp. To accomplish this a number of incandescent lamps are arranged in a circle on a rotatable disc as shown herewith. This disc may be rotated by hand or by an electric motor. The lamps have metal bases and a metal brush contact is caused to press against one base at a time. All the lamp bases have one of their poles connected to a common return contact, made in the form of a ring at the back of the disc, against which a second metallic brush makes contact. As seen it now becomes possible to rapidly switch one lamp after the other into circuit, consecutively. The persistence of vision of the retina of the human eye defies the detection of the lamp substitution, the intermittent flashes producing the effect of a steady light. Each lamp is in consequence lighted for so short a time period that the infinitesimal amount of heat developed is quickly dissipated. The *cooling* interval is about twice that of the *light* interval. The lamps, moreover, can in this way be operated on 3 to 4 times the normal voltage, vastly increasing the efficiency and illumination of each filament thereby. It is said that Dussaud has succeeded in obtaining 250 to 800 C.P. of *cold light* for several hours from a bank of 16 lamps rated normally at only 25 to 80 C.P. with an energy in-put of 50 to 160 watts.



Top Center View—A "Cold Light" Projector of the Dussaud Type Intended for Use by Firemen and for Military Purposes. Center—Rear View of "Cold Light" Machine. Lower Center—A Three-Lamp Projecting "Cold Light" Apparatus.

Professor Dussaud employs an optical system with his lamps, in other words, either lenses or mirrors. The result is that while the heat effect of the electric current is dissipated over a great area, the luminous rays are concentrated in a very small point or space. The tungsten lamps employed are of Dussaud's own design. Some of them are only 0.8 to 1.6 inches in radius. Groups of three are used in some models. They are successively flashed in the focus of a condensing lens, without breaking down the filament or blackening the bulb. Indeed, it is said that the results produced are identical with those obtained with an electric arc *ten times more intense.*

For motion picture projection machines the new cold light possesses wonderful merits, enabling the operator to run the film off as slowly as desired, and even to stop the film for examination when necessary. Dussaud, scientist, has projected motion pictures on a screen 15 feet square with an electrical energy consumption of 150 watts, compared to the 5 to 10 kilowatt (5,000 to 10,000 watts) arcs now used. And the cold light machine, complete with generator, could be carried easily in the hand. Due to this rapid dissipation of heat, it becomes possible to employ celluloid instead of glass plates for ordinary lantern slides with no danger of igniting the celluloid or of causing it to shrivel up. Dussaud has prophesied that with his cold light it will be possible to use celluloid films ¾ of an inch by 1 inch in size instead of glass plates 3¼ by 4 inches. The celluloid can be cut into long strips, perforated along the edges so that it can be printed mechanically, as in making moving picture positives. Indeed, he claims that a single operator can make twenty-five thousand celluloid prints a day. These tiny photographs can be made by any amateur at a cost of not more than a cent, and can be projected on the screen by means of small, low-priced projectors.

Above—The Microscopic Projection of a "Cold Light" Beam as Devised by Prof. Dussaud of France.

By utilizing the marvelous cold light auto-chrome plates can be projected, which otherwise suffer when exposed to the intense heat of the electric arc. Powerful lights can be concentrated upon parts of the human body without danger of scorching them, with the result that foreign bodies can be located very readily in the muscles.

The cold light lends itself admirably to the photographing of interiors. The inconveniences attending the use of ordinary magnesium flash powder are well known. Powerful cold lights render it possible to make very brief exposures without filling the atmosphere of the room with smoke and fumes.

With a small electric battery and a simple lens, a beacon light of long range can be cheaply produced. Such an apparatus will be found serviceable on small sailing boats as well as by soldiers. It is easy enough with such a device to telegraph optically for great distances. One of the views shows the microscopic projection of cold light.

How the Submarine Can Hit a Ship It Never Sees

By H. WINFIELD SECOR

THE German submarine has finally become a most menacing factor in the great world-war and now presents a first-class problem to all the would-be and master inventors —electrical, mechanical—and fourth-dimension. Remember reading now and then in the daily papers how "another" merchant vessel was torpedoed and the officers *saw no submarine?* Sank in 10 minutes and crew left in the water to float ashore or possibly to be picked up by a patrol boat. Yes, there have been a lot of such cases as this and even more mysterious ones. For instance there is the case where the ship's lookout remembers having seen an enemy submarine several miles off—much too far to be within torpedo range. Moreover, nothing more had been seen of the enemy after the first sighting, but suddenly—a terrible explosion fairly lifted the boat out of the sea—torpedoed? Sure as guns? But how? asks everyone, from Captain down; yes, how? and in broad daylight!

That's the question—and it now seems that there is an answer. Possibly the reader has guest it by looking at the accompanying illustration. At any rate here's a new aspect, and what is more, a thoroly practical one of the science of submarining. Let us admit that the officers on the merchant ship spot a periscope several miles away, or even a mile and a half away. That's an almost impossible target to hit with any kind of gun and the chances are the submarine couldn't shoot a torpedo once in ten times to hit the merchantman at such a range.

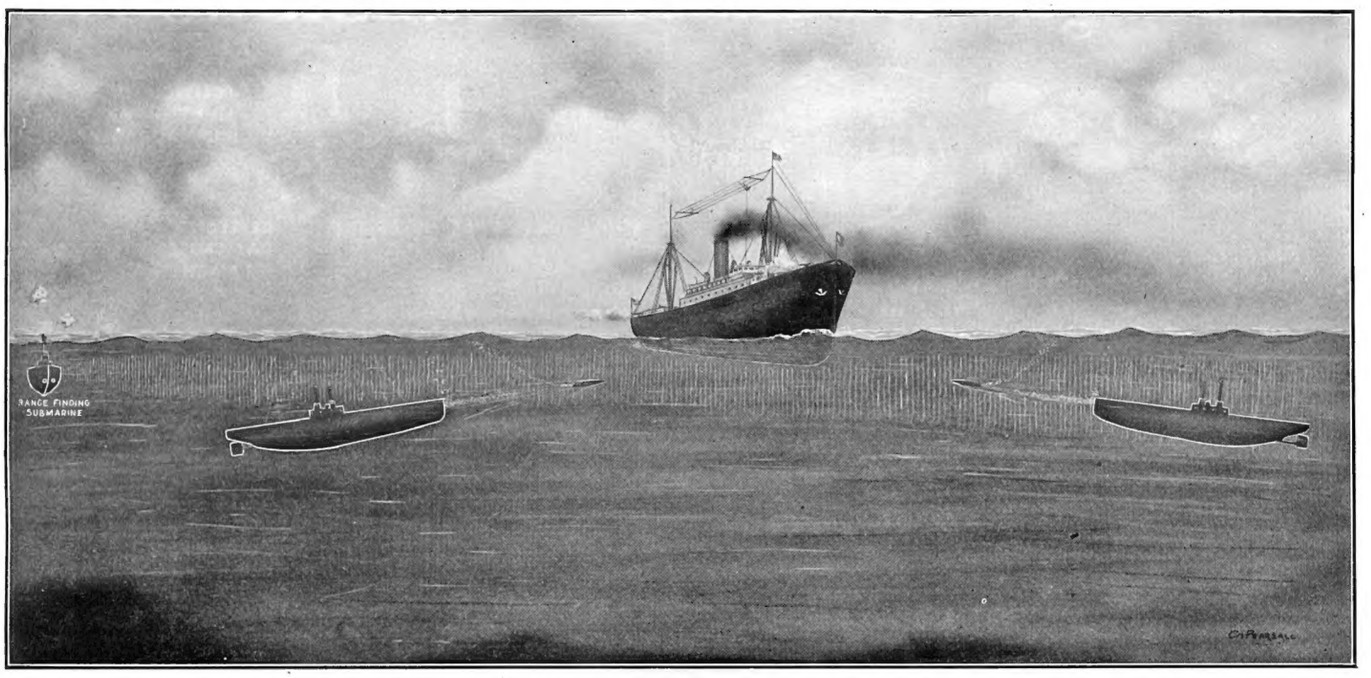
However, the German sub-sea boat commander doesn't have to worry about sinking the freighter with a torpedo from *his* submarine. Not at all. Give him a few minutes to draw a bead on your position and your speed, as well as the course, with his periscope and range-finding instruments. That is all the information he requires to sound the death knell of the proud merchantman.

And sound it he does, for as soon as he has the necessary data on your status and position, he at once transmits it thru the water by powerful sound waves to one or more submerged sub-sea fighters lying in the path of the on-coming steamer. Knowing the location, direction and speed of the unsuspecting commerce boat, the hidden submarine (or submarines) can discharge a torpedo sufficiently accurate to spell the finish of the "barred zone" prey.

The illustration shows this remarkable maneuver in a grafic manner. The merchantman may even fire on the periscope of the distant submarine, but as aforementioned the chances of hitting it at a range of 1½ to 2 miles are very slim. Besides, the spotting submarine may have been watching the steamer for some minutes before the latter's look-out spies the cunningly disguised and mottled periscope. At the first shot from the steamship's gun crew the submarine may disappear. Consider that the U-boat commander has the range of the enemy; he at once dispatches the data by sub-sea telegraphy or telephony, so that other U-boats lying submerged or awash at the surface, will receive the information on their sound wave apparatus.

All this may sound somewhat mythological—but it is not. Our own sub-sea fighters and war vessels are all equipt with similar instruments. They are based upon the researches of Prof. Reginald A. Fessenden, the well-known American inventor and scientist, and involve the principle that water will transmit sound waves remarkably well. To set up such sound waves of sufficient power to carry several miles (in tests, this method of communication has worked up to 20 miles) a special heavy diafram is employed, which is caused to vibrate rapidly by electromagnetic means. A similar diafram is used at the receiving station, and which is set into vibration by the sound waves or vibrations in the water. Prof. Fessenden has succeeded in telephoning several miles by means of such sound vibrations propagated thru water. Thus we see how it is not only feasible, but entirely possible for a submarine to torpedo a ship without ever having seen it.

(The above-mentioned sound wave sub-sea telegraph apparatus was fully described, with photographs, in our August, 1915, and February, 1916, issues.)



The Latest Reports Regarding Submarine Activities Frequently State that the Ship Was Torpedoed by an "Unseen" Sub-sea War-vessel. This Can Easily Be True for, by Utilizing Telegraphic Sound-waves Propagated Thru Water (Fessenden System), a Relatively Distant "Range-finding" Submarine Can Signal Her Hidden Allies as to the Position and Course of the Enemy. Thus the Submarine That Fires the Fatal Torpedo Need Never Show Its Periscope.

ELECTRICAL TREATMENT OF BRITISH WOUNDED.

In a recent number of the "Lancet," Dr. W. J. Turrell describes various applications of electro-therapy at the Radcliffe Infirmary, Oxford, England. One interesting point is the treatment of unclean wounds by ionization, produced either by the application of salt solutions traversed by an electric current, or by means of ultra-violet rays. As is well known, electric currents are now much used in treating certain varieties of rheumatism.

Of considerable importance is the application of mild electric "shock" to stimulate the voluntary movements; the treatment is specially efficacious in those cases of nerve shock where the patient is under the delusion that he has lost the power of his limbs.

However, the application of electric methods to cases of "shell-shock" calls for discretion. In some such cases the patient is not at all benefited and, indeed, exhibits "electrophobia."

Currents are also a valuable means of testing the action of various muscles and the powers of sensation, and in producing movements which break down internal adhesions or the binding of scar-tissue. The static machine is considered specially useful in this direction.

Does Radiant Light Possess Weight?

By A. R. McPHERSON

THE study of light presents some very interesting facts in regard to that mysterious force of Nature, which permits man to view the visible objects of this material world, and altho we are still in the dark, so to speak, as to the true nature of light, much progress is being made which will perhaps, even in the present generation, reveal the facts concerning light. The first theory advanced as to the nature of light was the *materialistic* theory, which involved the idea that light was composed of *material particles of matter.* This theory was rejected years ago, but like the alchemists' dreams of the transmutation of matter, which it seems is now becoming a reality, so this materialistic theory is again coming into favor.

The present generally accepted theory states that light is identical with electro-magnetic disturbances, such as are generated by oscillating electric currents or moving magnets; but this must presuppose the existence of an imaginary medium called *ether,* which is supposed to pervade all space, and is in the interior of all bodies of whatever nature. It is thin, elastic, and capable of transmitting vibrations with enormous velocity. Every luminous body is in a state of vibration and communicates vibrations to the surrounding ether. This, in short, is the electro-magnetic ether theory which has been evolved in recent years.

It is the belief of many, however, that *ether,* to exist at all, must be in a material form such as a gas, in order to harmonize with natural laws. To quote from "New Knowledge": "Mendelieff, the Dean of chemical science, has recently originated the conception that the ether, instead of being some mysterious form of non-matter, as generally believed, is actually the lightest and the simplest of the elements, and a *definite form of matter.* He believes it to be one of the inactive gases of the Argon family of elements and he assigns to it the position 'X,' in the zero group of his revised periodic arrangement of the elements. The atomic weight of the ether he concludes to be one-millionth of that of *hydrogen* and its atoms consequently travel with enormous velocities. This extreme velocity explains the all-pervading character of the substance."

Prof. T. J. J. See, a scientist whose researches are known thruout the world, recently made public the following statement in regard to light:—"The whole theory of ether is abandoned as having no real existence, light being caused by electrically charged particles, shaped like eggs, revolving about their shorter axes."

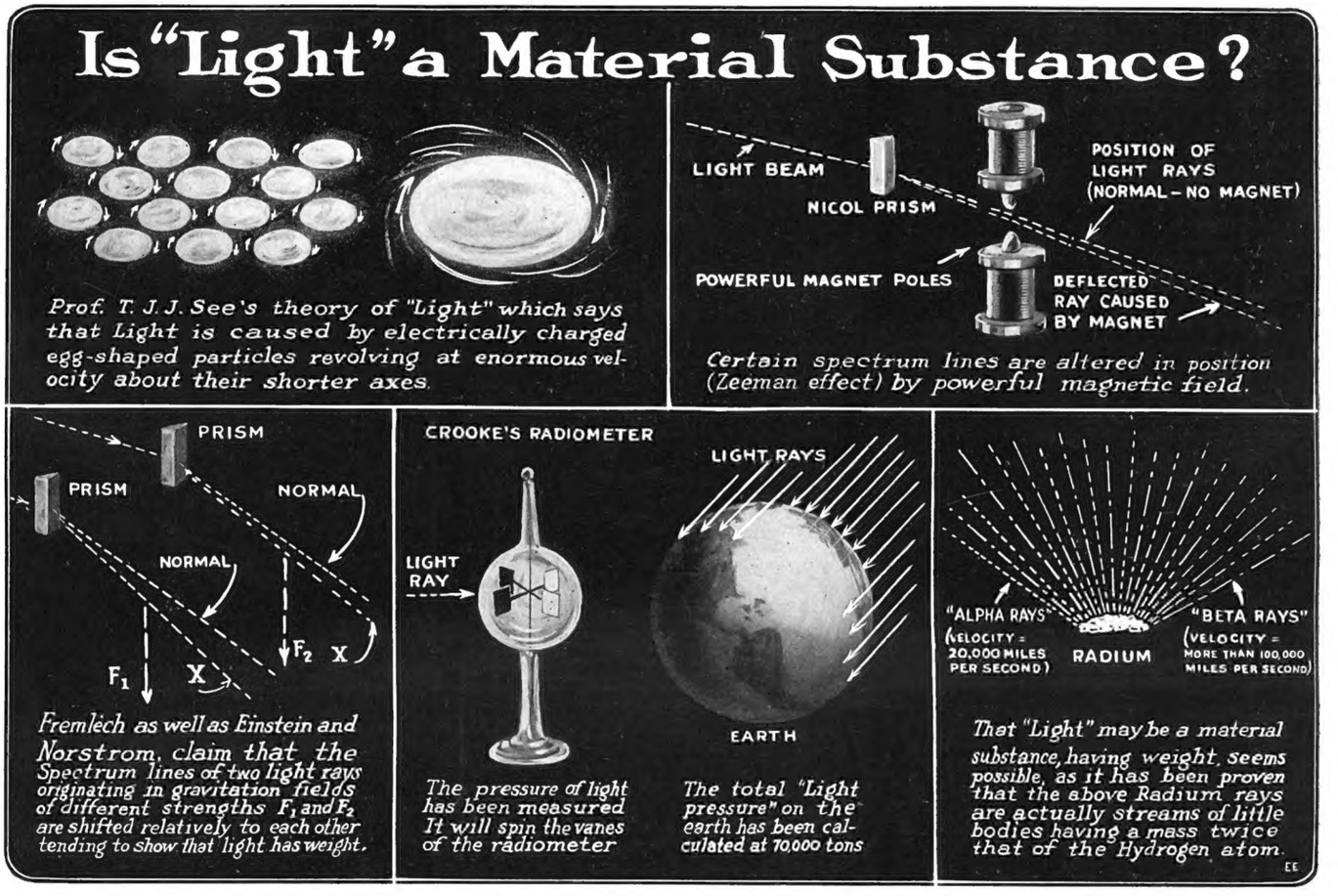
It would thus seem that there is considerable difference of opinion about the nature of light, and the writer has endeavored to gather together some of the leading facts and theories which tend to throw some "light" on the subject.

If it can be proven that light has *weight,* it must necessarily follow that it possesses material form and properties. No influence of any form of attraction on light had been noticed until about twenty years ago, when Zeeman showed that a powerful magnet visibly altered the position of certain lines in the spectrum.

Now it appears that gravitation has a similar, tho not the same effect. According to the theories of Einstein and Norström, there should be a real influence of gravitation on light. It is asserted that the spectrum lines of two light-rays originating in gravitation fields of different strengths are shifted relatively to each other. As Fremlech has now shown, the shifting is very well explained, so far as its amount is concerned, by Einstein's theory. An influence of an impulse proceeding from the sun, on shifting, cannot be the cause; for in this case, single lines would be shifted in different degrees. But the measurements show that the shifting of the lines, both in amount and direction, is the same for all, as Einstein's theory of the influence of gravitation requires. The shifting of the lines calculated with Einstein's formula agrees remarkably well with the average observed values. The influence of gravitation on light may now be regarded as partially proved, and thus it may also be inferred *that light possesses weight.*

From the above facts it may be demonstrated and must also be proven that light exerts pressure, since it is a material substance possessing weight. This peculiar truth was proven mathematically as early as 1873 by Maxwell, tho it was applied then and still is to a certain extent in support of the *electro-magnetic wave theory.* In 1901, Peter Lebdew actually proved and measured the *mechanical pressure of light.* The pressure discovered was small, of course, but the minuteness of a thing is often an inverse measure of its importance, as this light pressure has been found adequate to explain some of the earth's greatest

(*Continued on page* 215)


Is "Light" a Material Substance?
Prof. T. J. J. See's theory of "Light" which says that Light is caused by electrically charged egg-shaped particles revolving at enormous velocity about their shorter axes.
LIGHT BEAM
NICOL PRISM
POSITION OF LIGHT RAYS (NORMAL – NO MAGNET)
POWERFUL MAGNET POLES
DEFLECTED RAY CAUSED BY MAGNET
Certain spectrum lines are altered in position (Zeeman effect) by powerful magnetic field.
PRISM
PRISM
NORMAL
NORMAL
F1
X
F2
X
Fremlech as well as Einstein and Norstrom, claim that the Spectrum lines of two light rays originating in gravitation fields of different strengths F1 and F2 are shifted relatively to each other tending to show that light has weight.
CROOKE'S RADIOMETER
LIGHT RAY
The pressure of light has been measured It will spin the vanes of the radiometer
LIGHT RAYS
EARTH
The total "Light pressure" on the earth has been calculated at 70,000 tons
"ALPHA RAYS" (VELOCITY = 20,000 MILES PER SECOND)
RADIUM
"BETA RAYS" (VELOCITY = MORE THAN 100,000 MILES PER SECOND)
That "Light" may be a material substance, having weight, seems possible, as it has been proven that the above Radium rays are actually streams of little bodies having a mass twice that of the Hydrogen atom.
EE

War and Radio In the Movies

THE hero of the realistic Bluebird photoplay—"Treason," is a Government telegrapher in the service of a mythical European country at war with its neighbor. He is selected to go to the front, and this arouses the jealousy of his chief, who regards it as a personal affront. Pettrus distinguishes himself at the front as a telegrapher, and is invalided home. He finds, instead of promotion, that he is degraded to the position of messenger. His chief has tampered with a telegram, ordering him to spare Pettrus as much as possible.

He feels deeply the neglect of his country, and confides his feelings to his friend the tobacconist, who in reality is a "spy." The man sends information to the enemy (top view) by means of wireless apparatus concealed in a trunk in his rooms. (extreme right photo). He works upon Pettrus' resentment until he finally persuades him to steal the new code from the home of the Head of the Secret Service, with whose daughter Pettrus is in love. No sooner has he done so, than he repents, and would give anything to undo his act.

The Head of the Secret Service has been watching the tobacconist, whom he knows to be a spy. He now questions Pettrus, who finally confesses. The Head of the Secret Service helps him to recover the code. There is a thrilling automobile chase, which ends in a terrific smash over the side of a cliff. The tobacconist is killed, and Pettrus seriously injured. In the hospital, he returns the code to the Head, who promises that his act shall be a secret between them. The woman with whom his Chief has been on terms of intimacy finds the doctored telegram, and in revenge for neglect, exposes the Chief to the Head of the Government telegraph department. The delayed reward for Pettrus' services arrives, and the spite work of his Chief is revealed.

The Universal serial "The Voice on the Wire" is concerned with a series of murders, committed in the same way, by an attack on the victim over his heart which leaves a bruise the size of a human thumb. No other clue is left except a message from a mysterious voice spoken over a disconnected electric wire, which warns the victim of his end, and exults over the detectives, as each time they fail to circumvent it. In the eleventh episode, a strange invention is introduced. This is a material development of the science of mental telepathy. (In the "movies," they do it!) By a wireless arrangement, the mind in control can communicate with the mind it influences, and the machine is made to register the thought. By its use (central view here shown) the investigator who is tracing the crimes, learns of the plans of a group of criminals, who are supposed to be connected with the murders, and in whose power the girl who he loves was formerly held.

The enemy having "captured" New York City, in Greater Vitagraph's preparedness spectacle "Womanhood," Harry Morey, who plays the part of Paul Strong, Director of Energies, U. S. A., proceeds to evolve a plan by which he can be appraised of their movements and act accordingly.

Mary Ward (Alice Joyce) the Heroine of the War Film-Play—"Womanhood" Is Caught Using Her Pocket Radiotelephone Set.

Top Center:—A Stirring Scene from "Treason," the Great Photoplay of War, Radio and Love. Center Scene:—A Moment from Universal's—"The Voice on the Wire." Lower Center:—Paul Strong, Director of Energies, U. S. A., in "Womanhood," Receiving a Report from His Sweetheart in the Enemy's Stronghold (Extreme Left) "Via Radio."

His sweetheart, Mary Ward, played by Alice Joyce, is also the object of Prince Dario's enamouration. Count Dario is one of the commanders of the invading host and the son of Marshal Prince Dario, the militaristic Commander-in-Chief of the Ruritanians, the name given the "enemy."

Thru Count Dario's influence, Mary is offered a position in the invader's headquarters which is located in the Woolworth Building. Mary seeing in this an opportunity to serve her country, accepts, and vehemently denounces her native land.

Paul Strong, perceiving in Mary's position an opportunity to strike a telling blow to the "enemy," accordingly outfits a wireless telephone contrivance whereby Mary, thru her close association with the "enemy," can inform him of their plans without incurring their suspicions. (See left and lower center photos.) The copper gutters on the roof of the Woolworth Building are used as antenna. Mary employs a pocket radiophone instrument, which she connects with the improvised antenna, thru a secret switch, cleverly hidden in the brass scroll work of an electrolier on the side wall.

ODDLY IDENTIFIED BY RADIO.

American naval officers are highly amused over a recent "wireless romance" connected with an American destroyer. The story well exemplifies traditionary sea caution and hangs on the fact that by reason of two Americans having been roommates at St. John's College at Annapolis years ago, information was confirmed at sea that otherwise would have remained doubtful.

One man is a civilian doctor, who has taken an important post in Great Britain, the other is a paymaster in the navy. Two days before the destroyers sailed from the United States these old friends ate a farewell dinner. The doctor was to sail by a liner, but was ignorant of the ship's name and date of sailing. The paymaster was under orders to join his destroyer.

Here You Have a Chance to See a Spy's "Trunk" Radio Apparatus at Work. An Absorbing Moment from the Master Photoplay—"Treason."

When several days at sea the destroyer got into distant connection one night with a certain vessel, and made a code inquiry as to the vessel's position, course, and speed. No direct reply was made, the vessel fearing a submarine trick and the possibility of a stolen codebook. Instead of answering a demand was made to the destroyer: "Give the name of your ship in code." The destroyer complied.

Even this was not enough. A second wireless was sent out: "What is the name of your paymaster who is the friend of Dr. ————, a passenger aboard this ship?"

Then the paymaster of the destroyer was called into the wireless cabin and asked if he knew Dr. ————. "Sure," he replied. "He was my best pal. We were roommates at college, and had dinner together two nights before I sailed. Where is he?"

The destroyer sent out another radio, saying: "Paymaster ————, the doctor's oldest friend."

After this corroborative statement the vessel at last gave her position, course, and speed.

U. S. Battleships to Run on Land

By H. GERNSBACK

EVERY war brings out a host of fantastic as well as ridiculous new inventions which are supposed to annihilate the enemy. Most of these wild-cat schemes are of course as impractical as they are fantastic, and while they look good on paper, the devices do not stand up in practise, either because of inherent defects or because science and technic have not progrest sufficiently to do justice to the device.

Thus a submarine invented by no less a genius than Robert Fulton, propelled by several men and which was actually run under water, was sanctioned by Napoleon, the inventors hoping to sink the blockading English fleet. The submarine failed miserably, to Napoleon's utter disgust. Nevertheless the failure was not due to the principle being inherently wrong. Rather science had not progrest sufficiently to make the submarine a success one hundred years ago. Napoleon, if he were to come back today, would certainly experience a radical change of mind, as to the success of the submarine.

In the same manner, when John Ericsson constructed the "Monitor" in 1862, he was met with a good deal of ridicule—at first. No one believed that his steel "cheese-box on a raft," war vessel could do much damage, or even give a good account of itself, let alone winning a battle. The world knew different after the "Monitor" defeated the famous "Merrimac."

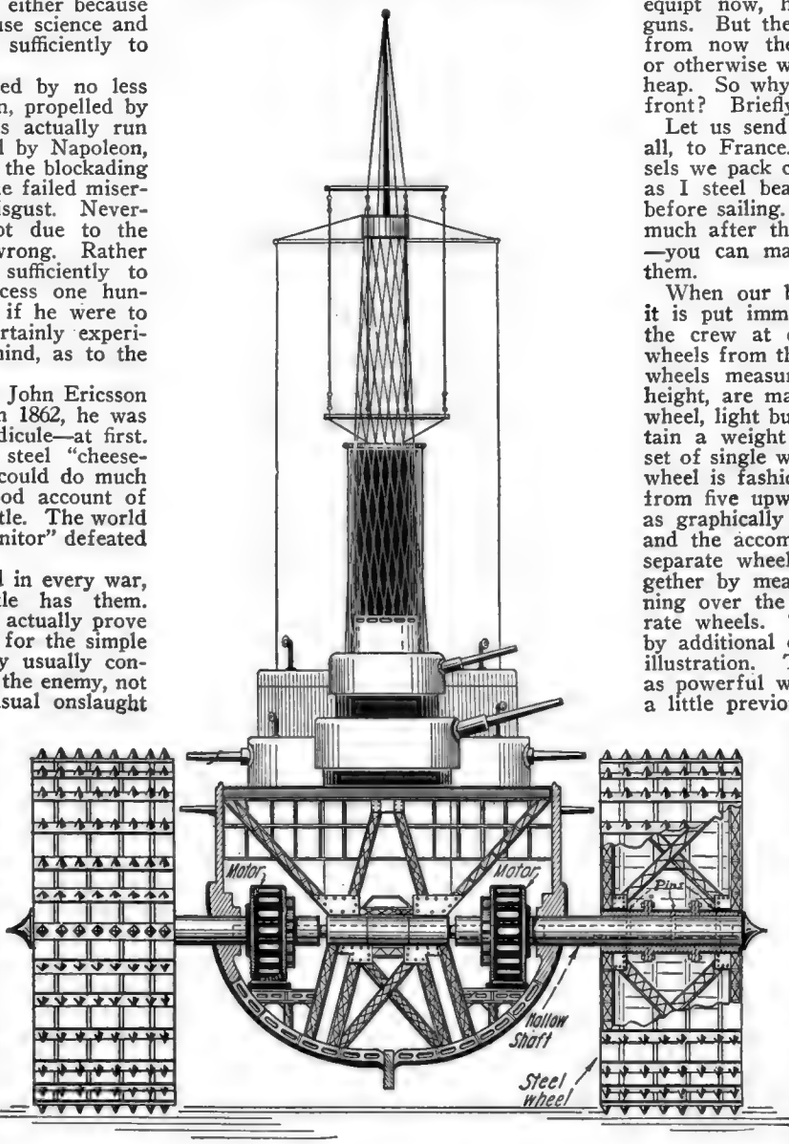
Makeshifts have been used in every war, and every important battle has them. Sometimes these makeshifts actually prove decisive in a battle, perhaps for the simple reason, that insofar as they usually contain the element of surprise, the enemy, not being prepared for the unusual onslaught is defeated.

Perhaps the most famous instance where a big battle was won with a makeshift was the Battle of the Marne, in 1914. No more impossible or ridiculous weapon than an ordinary taxicab could be imagined to launch a modern army, equipt with the world's best artillery. Nevertheless, when the defender of Paris, General Gallieni, requisitioned every Paris taxicab, and flung these thousands of squeaky vehicles, which had never been designed for such work, against the German hordes, they simply had to give way; and the taxicabs won. One of the world's greatest retreats was mainly due to these peaceful fare-eaters. Perhaps taxicabs will never be used again in such a manner, but at any rate they did their full duty once. The experiment proved worth while.

Therefore when I propose to run battleships over land, I am fully aware of the ridicule I will be subject to. I am also aware of all the objections that will be cited against the fantastic-appearing plan. Nevertheless, I insist that the idea is not half as impractical as it may appear at first. And at any rate I believe I have found a way showing how it may be done in a simple manner. I give the idea to the country for what it is worth.

I do not claim to be the originator of the idea to run battleships or other ships over land. That idea is old already. Twenty-five years ago there was published in a German weekly an idea to run a powerful car, moving over a dozen closely spaced paralleling tracks, under a ship. This car, after the ship was made fast to it in a suitable manner, was then to be drawn overland—over the present Panama Canal route—by powerful locomotives.

Lately other plans have appeared showing battleships running thru cities and over the houses, but no one volunteered to show how it might be accomplisht. A battleship weighs anywhere from 10,000 tons upwards—quite a respectable weight. How then can we run such a monster on land? How can it be propelled?



Putting Wheels on Our Battleships and How It Is Accomplisht. The Wheels Here Shown Are Fashioned of Angle and I Steel Beams, on the Plan of Structural Steel Toys. Such Wheels Are Tremendously Strong. Slow Running Electric Motors Coupled to the Steel Shafts Drive the New Monster Over Land.

Now that we are at war, our first duty is to help our allies, *and to help them quickly.* The time is too short to build new colossal war engines which could be used at the front at once. Our army will not be fully ready till a year from now. Our navy cannot help very much on sea. For if the British, French and Russian navies, which are at least four times as powerful as the German navy, cannot destroy the latter, the addition of our own navy will not matter much one way or another. The German navy simply stays behind her mine fields and bides her time.

But the U. S. navy has a number of battleships of the pre-dreadnought type, good ships as yet, but obsolete as first-line ships. I refer to ships of the *Oregon, Iowa, Illinois, Kentucky, Massachusetts, Indiana* class. These ships are fully equipt now, have good crews and good guns. But the chances are that ten years from now they will be used as targets or otherwise will be relegated to the scrap-heap. So why not send these ships to the front? Briefly, the idea is this:

Let us send these ships, men, guns and all, to France. In the holds of the vessels we pack channel irons and T, as well as I steel beams, cut to the right length before sailing. These pieces are fashioned much after the structural toy steel pieces—you can make almost anything out of them.

When our battleship arrives in France, it is put immediately into dry dock, and the crew at once proceeds to make the wheels from the channel steel. These huge wheels measuring over 50 to 60 feet in height, are made on the plan of a Ferris wheel, light but strong. Of course to sustain a weight of 10,000 tons or more, a set of single wheels won't do. Rather each wheel is fashioned of a number of wheels from five upwards, paralleling each other, as graphically shown on our front cover, and the accompanying illustration. These separate wheels are bolted or riveted together by means of steel "I" beams running over the circumference of the separate wheels. The latter are strengthened by additional cross-truss work, as seen in illustration. Thus a very light, as well as powerful wide wheel is formed. With a little previous drilling, the crew should be able to construct the necessary six wheels in less than one week—yes, it can be done; providing the pieces are cut to the right dimensions at home.

Next the *thirteen inch* hollow steel shaft is considered. This, of course, has been brought from America too. The hollow shaft is advised, first because it weighs less, and second because such shafts are equally as strong as solid ones, within a reasonable proportion.

The two wheels at the stern are "idlers," the same as the front wheels on an automobile. No power is applied to them, they simply rotate on the shaft, extending from one wheel to the other, clear thru the ship. The two small center wheels are also idlers. They serve to take up undue shocks, which might break the ship in two, when negotiating difficult terrain.

The two front (bow) wheels are the "drivers". They are bolted solid to the shafts, two of the latter being used as will become apparent at once. Our illustration shows that the two shafts revolve in a common bearing (which might be an old reconstructed gun barrel). Each shaft in turn is directly coupled to a slow-running electric motor armature, as clearly shown. And this, by the way, is the much discust electrical drive, adopted in our latest monster battle cruisers, now being constructed. From this it becomes apparent how the land battleship is propelled overland in a simple and practical man-

(*Continued on page* 216)

The Marvels of Radio-Activity

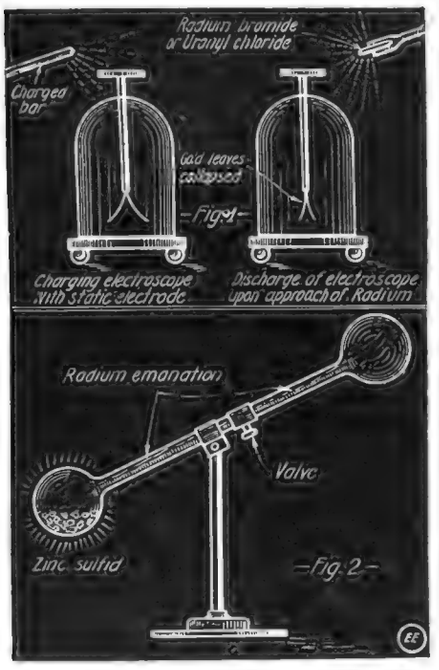
By JEROME S. MARCUS, B. Sc. (Ch. E.)

First Paper of a New Series

THE subject of Radio-activity deals, not only with Radium as many believe, but with a whole class of substances, the best examples of which are Radium, Uranium, Thorium, Actinium, and the chemical compounds of these substances. *Radio-activity* is the name given to the property which these substances have of giving off or emitting certain radiations spontaneously, these rays having the power to penetrate thru matter which is opaque to ordinary light.

History.

Shortly after the discovery of X-rays and their properties by Professor Röntgen in 1895, many students of physics began to investigate the different phosphorescent bodies to ascertain whether they would or not emit rays of the same character. Professor Henri Becquerel, a Paris physicist, discovered in 1896 that the compounds of Uranium which had a phosphorescence (that is, they would glow in the dark after exposure to daylight) would weakly affect a photographic plate. He then found that salts of Uranium which were not phosphorescent also affected a plate, thus showing that it was the element Uranium which possest the peculiar ray-emitting property.



Top:—Discharging an Electroscope by Radium. Lower Illustration Shows a "Radium Light" Which Will Give Sufficient Illumination to Read By.

It was then found that these rays or radiations of Uranium, like X-rays, would discharge electrified bodies, produce phosphorescence in certain other bodies, and penetrate many things that ordinary light would not. Fig. 1. (Experiments on these points will be given later.) These rays were named after their discoverer, "Becquerel rays." It was also found that in carrying these ray-emitting substances around in one's pocket, burns which are very hard to heal are caused, known as "Becquerel burns."

Gold Bar, About the Size of an Ordinary Building Brick, Worth $18,268.53. Tube of Radium the Size of a Match, Worth $18,000.00 (150 Milligrams at $120.00 Per Milligram). Photographed in the Mint, at Denver, to Show Relative Value of Gold to Radium.

Investigation of these radiations were immediately taken up, especially by E. Rutherford, then a student in the laboratory of J. J. (now Sir) Thomson at Cambridge, England. Their properties will be discust later.

Mme. Curie, of Paris, made a systematic investigation of a large number of substances to test whether they possest the same rays as Uranium. At about the same time, in 1898, she and Professor Schmidt discovered that Thorium and its compounds were radio-active. Mme. Curie and her husband then began an exhaustive investigation of the Uranium compounds, and found that the activity was an atomic property, *i.e.*, it was proportional to the amount of Uranium present. While working on this basis with *pitchblende*, an ore from Joachimsthal, Austria, which contains Uranium, she found that the activity was four or five times greater than it should be. This led her to the conclusion that there must be something else with stronger properties than the Uranium. The Austrian Government placed a large amount of the ore at her disposal, and she set about separating the extremely small amount of this then unknown substance. Her efforts were finally rewarded by the isolation of "Polonium" and a substance of such intense ray-giving power that she termed it "Radium." *Radium bromide* has about two million times the activity of Uranium.

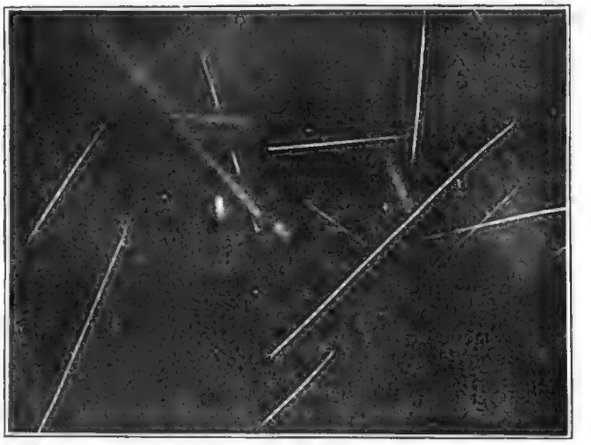
Radium has been found to be an element of definite atomic weight, and accompanies the Barium which is separated from the pitchblende. It is not proved as yet whether Polonium is an element, but it accompanies the Bismuth in the ore, and is separated from it.

The discovery of these substances was made in 1898 and in 1899, M. Debierne discovered another radio-active material which he called "Actinium," and which follows the iron in the pitchblende and seems to be connected with the Thorium.

It has been shown by recent investigators that almost all substances in nature are more or less radio-active. Among these are freshly fallen rain or snow, many spring waters, etc. From this, the idea has been advanced that radio-activity is due to certain radiations from the sun itself. These are supposed to be connected with the appearance of the Aurora Borealis and other phenomena of atmospheric electricity. In the spring of 1903, Professor J. J. Thomson discovered that waters from deep wells contained a certain gas which was radio-active, and other substances are being found which also possess the power of radio-activity.

* * *

Becquerel showed that the rays from Uranium, like the X-rays, were capable of discharging an electrified body, when charged either positively or negatively. (Experiment—A gold leaf electroscope is charged by touching to any source of static electricity, *e. g.*, a glass rod rubbed with silk. An Uranium compound—any salt purchased from a chemical house, the author uses Uranyl chlorid in his experiments—is then brought near the knob. The leaves are seen to collapse. (Fig. 1.) This property of radio-active substances is used as a delicate quantitative test for the amount and intensity of radiation. A special electroscope has been devised for work in Radium research, the rate of collapsing



Remarkable Photograph of the "Alpha" Rays of the Radium Emanation. By C. T. R. Wilson.

(*Continued on page* 207)

Back to the Days of "Volta"

VOLTA, inventor of the first electric battery, after whom the standard International unit of electrical pressure—the *volt*—is named, was one of the early, most brilliant and indefatigable workers in the realm of pure electrical science. He was born in Como, Italy, Feb. 18, 1745, in a house which had been the homestead of the Volta family for over 300 years. Paradoxical as it may seem, true genius is often linked with less brilliant knowledge, had him write essays on electricity for the great men of the day, as people in general knew very little about this mysterious force at that early period.

The first formal scientific papers of Volta were issued in his 24th year and fourteen years later there appeared his *electrophorus* (see illustration, Fig. 1.) followed by his *electroscope*. The photographs here reproduced show the now historic apparatus built and used by Volta in his laboratory.

dium production companies employ this method in testing their products. Fig. 1 also shows various plate condensers, invented by Volta.

While professor of physics at Pavia, he conducted experiments which led to the discovery of the *Voltaic pile*. One of the accompanying illustrations, Fig. 4, shows one of the most remarkable historic documents extant—the original letter, written in French, of Alessandro Volta addrest to the

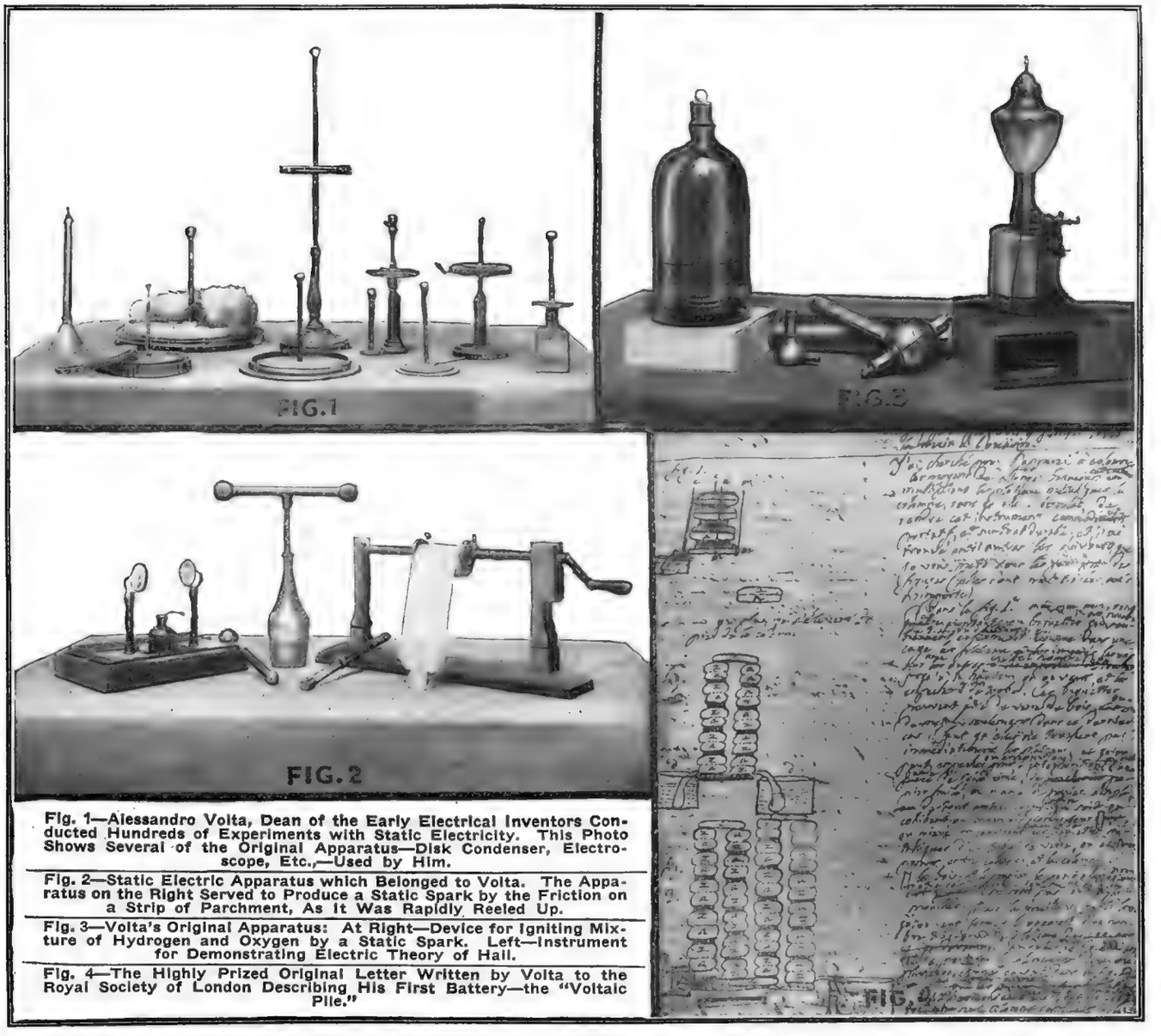


Fig. 1—Alessandro Volta, Dean of the Early Electrical Inventors Conducted Hundreds of Experiments with Static Electricity. This Photo Shows Several of the Original Apparatus—Disk Condenser, Electroscope, Etc.,—Used by Him.

Fig. 2—Static Electric Apparatus which Belonged to Volta. The Apparatus on the Right Served to Produce a Static Spark by the Friction on a Strip of Parchment, As It Was Rapidly Reeled Up.

Fig. 3—Volta's Original Apparatus: At Right—Device for Igniting Mixture of Hydrogen and Oxygen by a Static Spark. Left—Instrument for Demonstrating Electric Theory of Hail.

Fig. 4—The Highly Prized Original Letter Written by Volta to the Royal Society of London Describing His First Battery—the "Voltaic Pile."

traits of character, and as a child we are told that Alessandro Volta was very backward. Even to the point that he could only speak one word "No," when he had reached his fourth birthday.

But, like many other great scholars of the world, he suddenly developed a great affinity for philosophy and became an earnest student of scientific subjects, especially the natural wonders of nature—particularly electricity. When he was 17 years old he had won prizes in philosophy and at 18, the famous Abbé Nolet, strongly imprest with the youth's superior and divining

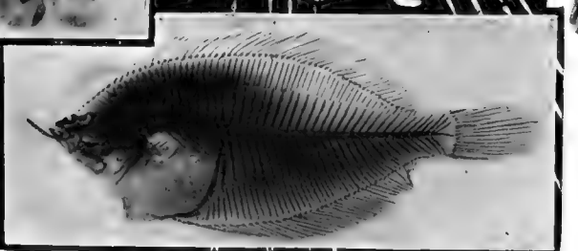
Fig. 1 shows a variety of electro-static apparatus, including a static electric charging device—the electrophorus, at extreme left, and the detector of static charges—the electroscope at extreme right. Both of these devices are still in use in electrical laboratories where the elements of pure science are studied. Besides, the electricians of today have found many practical applications for the electroscope, never even dreamed of by the illustrious Volta. One important commercial and highly important application of the sensitive electroscope is in the measurement of radio-activity. The Ra-

Société Royale de Londres describing his new electric battery (Voltaic pile), consisting of alternate zinc and copper discs separated by dampened blotter paper sheets. This formed the basis of present-day electric batteries. There is no doubt that modern electricity really starts with this famous letter. For it was Volta's battery that produced the very first electric galvanic mark. It was Volta who led the first galvanic current thru a wire. And it was his battery that produced for the first time useful dynamic electricity.

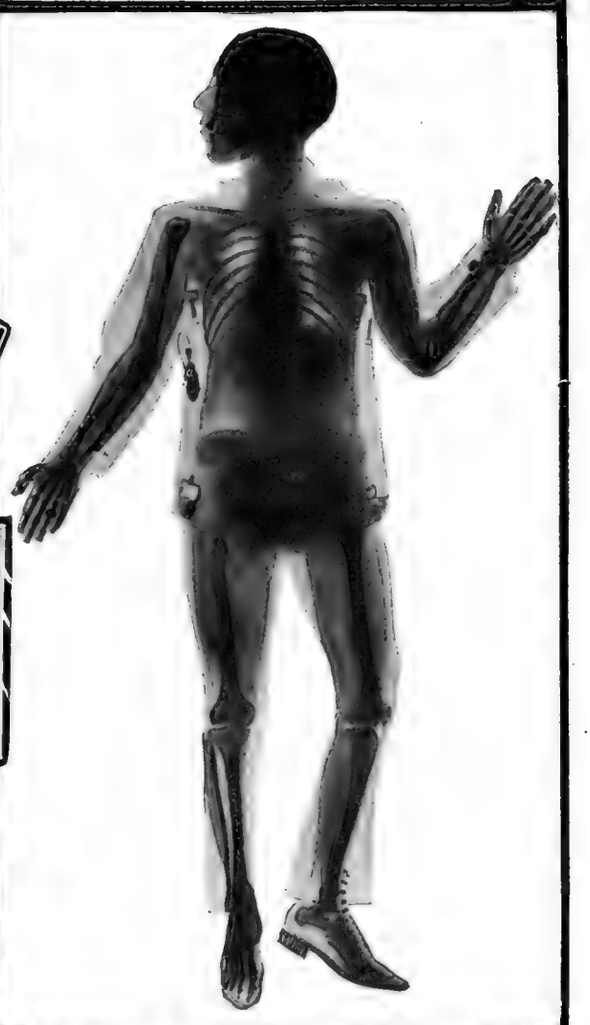
(*Continued on page* 212)

SOME ODD X-RAYS

In Child-hood Days We Used to Enjoy Reading About the Two-headed Giants Who Strode Over the Land with Seven League Boots. But Here We are Face to Face with a Real Two-headed Human Being. The X-Ray Shows the Two Distinct Spines Very Clearly. (Photo from Dr. W. B. Snow.)



"I Never Eat Shad Because It Has so Many Bones"—That's What They All Say. Speaking of Fishes, Ladies and Gentlemen, Meet This Rotund Member of the Finny Tribe in All His Glory of Bones of Every Shape and Size. What the X-Ray Reveals.



On Another Page There is an Article on Prof. Miller's Great Researches on Sound. Here You Have a Chance to Meet That Scientist, and as You See, He Wishes to Conceal Nothing from You. One of the Most Wonderful X-Ray Photos Extant, Showing As It Does the Entire Human Body, Clothes and All. Note the Watch, Keys, Pocketbook, Etc.

Remarkable X-Ray Photo of a Four-Legged Chicken, Five Hours Old. Now That the High Cost of Living Is Our Daily Topic It Is Pleasant to Note That Nature Comes to Our Aid and Beats the Poultry Trust to It. "Mom, I Want the Western Hind Leg" Will Soon Be Heard All Over the Country. Photo G. E. R.

Did You Believe That the New-born Child Had No Bones? Here's Evidence to Prove That the Stork's Gift Is 100 Per Cent Complete in His Physical Structure. (Photo Dr. W. B. Snow.)

Are You a Mason? If You Are Not, Perhaps You Can Figure Out What Mystic Order the Gentlemen Posing for This Skiagraph Belonged to. Note the Twisting of the Wrist Joints Due to Clasping Hands. (Photo from Dr. W. B. Snow.

Lightning—How to Protect Yourself From It

By W. G. WHITMAN, State Normal School, Salem, Mass.

LIGHTNING, that awe-inspiring natural phenomenon which compels the attention of child and adult alike, is the cause of about 800 deaths and of 1,500 injuries sustained by the people of the United States in a single year. It also causes the destruction of many millions of dollars worth of property yearly.

Lightning is a more vital subject in the country and small village than in the city. It is rare that lightning strikes in the large towns or cities. The isolated building or object is in greatest danger. The subject is of varying economic importance too in different states. Records show that lightning does more damage in Iowa than in any other state. Maryland, Wisconsin, New York, Ohio and Illinois follow in the amount of damage received from this source.

That the harmless spark obtained by rubbing a cat's fur in cold winter and the terrifying lightning of a hot summer day are closely related, belonging as they do in the same family of natural phenomena, has never been surmised by the average school pupil. In fact many older people have not thought of them as related phenomena, even tho Franklin proved their identity in 1752.

Benjamin Franklin while experimenting with electricity noticed certain resemblances between the sparks produced artificially and the natural lightning. Both flashes were instantaneous; gave intense light; followed a crooked path; produced noise; set combustible material on fire and killed animals. From observation of the similar behavior of the two, he was led to a strong belief in their identity, so he determined to perform some experiment which would prove their likeness or unlikeness. And on July 4, 1752, he sent a kite into the clouds during a thunder storm and succeeded in bringing electrical energy from the cloud thru the kite string to a key at its lower end. This string and key were insulated from the earth by a silk cord. Franklin obtained sparks from the key just like those he had produced in his laboratory, thus did he demonstrate to the world the fact that lightning is an *electrical discharge*.

Thousands of Cattle on the Great Farms of the West Are Annually Electrocuted by Lightning Discharges Which Charge "Ungrounded" Metal Fences and Demolish "Unrodded" Barns and Outbuildings. The Highest Authorities Recommend That All Buildings Be Equipt With Proper Lightning Rods.

The boy who shuffles his feet over the carpet and draws a spark from the water faucet or gas burner is a *dynamo* unawares; he generates electricity and discharges it at a pressure of thousands of volts.

It is usually true that the air above the earth is *positively* electrified and that the earth differs in electrical pressure from all space around it by many—possibly 150,000 volts. It is not constant, however; conditions are always changing and the electrical tension is variable. Such a difference of potential as this is not sufficient to produce lightning.

When clouds are rapidly formed by air currents rising into the air, enormous quantities of electricity are produced. We do not know exactly how it is produced. The latest theory, that of Dr. Simpson, explains the electrification as resulting from the splitting of rain drops into smaller particles as they tend to fall thru a rapidly rising current of air. In some way clouds do become highly charged with electricity. Sometimes they are *positively* charged and sometimes *negatively* charged. When two clouds or a cloud and the earth are at sufficiently great difference of potential the resistance of the intervening air is overcome and a discharge takes place producing the common phenomenon of lightning. Sir Oliver Lodge calculated that a flash of lightning one mile long is probably due to a difference of potential of 5,000,000,000 volts, but it is generally thought now that this figure is too high. Trowbridge has found that a difference of potential of about 25,000 volts between battery terminals will give a one-inch spark thru air.

The duration of a flash of lightning is usually under 1/50,000 second and may be only 1/1,000,000 second. Because of *persistence* of vision we apparently see the flash for a longer time. According to calculations made by Lodge, a discharge from a cloud 10 yards square, fully charged, at a height of one mile, liberates 2,000 foot-tons of energy. This energy is enough to warm 2½ quarts of water to the boiling point and then change it to steam in a trifling part of a second. Such intense heat warms the particles of air to incandescence and is the cause of the flash seen. Heated air conducts electricity better than cold air, so at times other flashes will follow in the path of the first one before the air has become cold. These multiple or oscillating flashes may continue for 1/1,000 to 1/200 second, but altogether they apparently make but one flash to the eye.

The discharge of this cloud, 10 yards square, gives enough energy, in 1/20,000 of a second, if properly directed, to hurl 1,000 barrels of flour 20 feet into the air. When this energy heats the air in the path of the lightning discharge it causes sudden expansion with explosive violence and when the expanded air cools and contracts a vacuum is formed, into which air rushes again with implosive force. When you blow up a rubber balloon to an excessive pressure, explosion results with a loud sound. When an incandescent bulb is broken, air rushes into the space, and when it meets it produces a loud sound from the implosion. These two cases illustrate the production of thunder. One part of a lightning flash may be a mile farther away from you than the nearer part. The thunder from the more distant part will reach you about 5 seconds later than that from the nearer part. Thus while a flash may be instantaneous, the thunder which you hear may be of considerable duration. Thunder from several flashes may unite. Thunder may be reflected by one or more clouds. In these ways the *rumblings*, characteristic of thunder, are produced.

Objects standing on the surface of the earth become a part of it and are electrically charged the same as the earth. Standing above the earth's surface they form excellent discharge points since the air gap from them to the cloud is less than from the surrounding earth to the clouds, and furthermore, the electrical density or ten-

sion is greater at points, corners and angles than on surfaces. Whatever the object may be thru which the discharge starts, it instantly becomes the conductor thru which electricity passes either to or from a large area surrounding it. If an object only discharged an amount of electricity equal to that which it held before the discharge, there would be little danger or violence, but when it becomes the conductor to carry the electricity of a considerable portion of the earth about it, the large quantity of electricity passing in so brief an interval causes violence and damage.

A similar discharge of the earth occurs when an object on the earth is electrified by a near-by cloud by induction and a discharge passes between them. The discharges at the storm front are usually the most severe. After the first few discharges the air seems to become a better conductor and the lightning is less severe.

Any high object reaching above the earth carries the electrostatic field nearer to that of the cloud, thus increasing the possibility of an electrical discharge between them. The tremendous heat energy which is produced from the electrical discharge of a large cloud highly charged is sufficient to heat air particles to incandescence, to melt minerals and metals, to vaporize solids and liquids with explosive violence and to set fire to combustible matter. It is little wonder that trees are splintered and buildings set on fire when they make a path for the lightning to the earth—or from the earth—for it is believed that fully as many discharges are from the earth to the clouds as from the clouds to the earth.

Protection against lightning is needed on isolated buildings, tall chimneys, steeples and flag poles. Such protection is secured by use of a metal cage or series of rods with high points and the whole thoroly grounded. The material must be of sufficient capacity to carry off large quantities of electricity and it must not corrode readily. Copper and galvanized iron are the two metals most commonly used for lightning rods. The lightning rods or conductors should not be insulated from the building because the object of the rods is to drain electricity from all objects about or a part of the building. Conductors ought not to be placed near or parallel to an inside pipe, because the discharge might jump thru the wall to it, causing fire, or it might produce a powerful heating effect in it, resulting from induction. A safeguard against such a disaster is to connect the lightning rod system at the highest and at the lowest points with inside structural beams and water pipes. Sometimes gas pipes are connected but because of the inflammability of gas, many prefer not to connect them. All exterior metal work of the building, as gutters, railings, etc., either should be connected to the lightning rod at a level below their own or they should be grounded by a separate cable. The grounding of lightning rods is a very important matter. They are frequently connected to large copper plates which are buried in a mass of coke at a depth which is below the permanent water level of the earth.*

The metal cage or rods should have a number of high points extending above the level of the building; and should have few joints and no sharp bends. Our commercial currents will follow good conductors around any amount of curving, but lightning will often jump off from a good conductor at a sharp bend, even tho it must pass thru a poorer conductor.

There are two ways in which lightning rods protect a house. First, they serve as conductors carrying the discharge harmlessly; second, they tend to discharge the earth slowly. Often such an amount of electricity escapes by this slow discharge that a lightning stroke is prevented, or if not prevented it is less severe. Occasionally a rodded house is struck, but the damage is much less than if the house had been unrodded. The idea that lightning rods draw lightning, and are a source of danger, is unfounded even if the rods are poorly grounded. The majority of fires resulting when lightning strikes rodded buildings occur when masses of metal, gutters, pipes, etc., *are not connected* to the lightning rods or *are not grounded.*

Actual Photograph Taken After a Severe Electric Storm Showing the Lightning's Toll in Valuable Live-Stock. The Barn Was Unrodded, as May Be Surmised, for It Is Very Seldom that Fatalities Occur Where Buildings Are Properly Covered with First-Class Lightning Rods, Thoroly Grounded in Damp or Wet Earth.

Sir Oliver Lodge classifies lightning as *"A" flashes* and *"B" flashes.* The A flashes are less sudden and violent, and are what the Germans term *cold lightning.* Lightning rods are effective protection against them. The B flashes are sudden and violent, and are what the Teutons term *burning lightning.* Lightning rods will not always safeguard against these flashes. Both the A and B flashes are fatal to man. *Ball lightning* is produced when the B flashes strike the ground. The A flashes are the more common. When a storm is at such a distance that flashes of light are seen but no thunder is heard, the flashes are termed *heat lightning.* The thunder may be refracted above the head of the observer or it may be at such a distance that its intensity is so decreased as to become inaudible.

If a person forms a part of the conducting path of the discharge, he is likely to suffer and yet the stroke may not prove fatal.

The heart is the chief danger spot. It is not the voltage but the current which passes thru the heart which is the important thing. Tho with a given body resistance, an increased voltage causes an increased current to pass. It has never been determined with accuracy just how much current can pass thru the human body with safety. It doubtless varies with individuals. High voltage causes paralysis which may stop breathing, and even the heart's action. First aid in lightning stroke should be *artificial respiration,* the same as is used to restore a drowning person.

No danger results when a comparatively large current flows thru the lower trunk alone, but as low a pressure as 65 volts has been known to prove fatal, when it past thru the thorax.

The resistance of the skin varies with its dryness, moisture, greasiness, and by the area which is in contact with an electric conductor. A bare wire carrying our ordinary lighting current at 110 volts or 220 volts pressure may be handled safely if the skin which the wire touches *is dry* or if the person's boots by which the current leaves

(*Continued on page* 212)

WHAT TO DO IN A THUNDER STORM.

If you are out of doors in a very severe electrical storm, it is well to observe the following rules for your own protection.

1. Keep away from wire fences. They may carry a dangerous electrical charge long distances. Cattle in pastures are frequently killed from the neglect of farmers to ground the wire of the fence.

2. Keep away from hedges, ponds, and streams.

3. Keep away from isolated trees. Oak trees are frequently struck; beech are seldom struck. It is safe in a dense forest.

4. Keep away from herds of cattle and crowds of people.

5. Do not hold an umbrella over you.

6. It is safer to sit or lie down in an open field than to stand.

7. Drivers should dismount and not stay close to their horses.

8. Do not work with any large metal tool or implement.

If you are indoors:—

1. Keep away from the stove and chimney. The hot gases from the chimney may conduct the lightning to and down the chimney.

2. Do not take a position between two bodies of metal as the stove and water pipe, for example. An exception to being near metals is the case of an iron bed. One of the safest places is on a mattress in an iron bed, provided you do not touch the metal. The metal surrounding you makes a safe cage which will prevent the lightning from reaching a person inside.

3. Do not stand on a wet floor nor draw water from the well or faucet.

4. Do not stand directly under a chandelier, near a radiator, nor on a register.

5. Do not use the telephone.

*Specifications for installing lightning rods are given in Technologic Paper No. 56, Bureau Standards, at 35c, procurable from Government Printing Office, Wash., D. C.

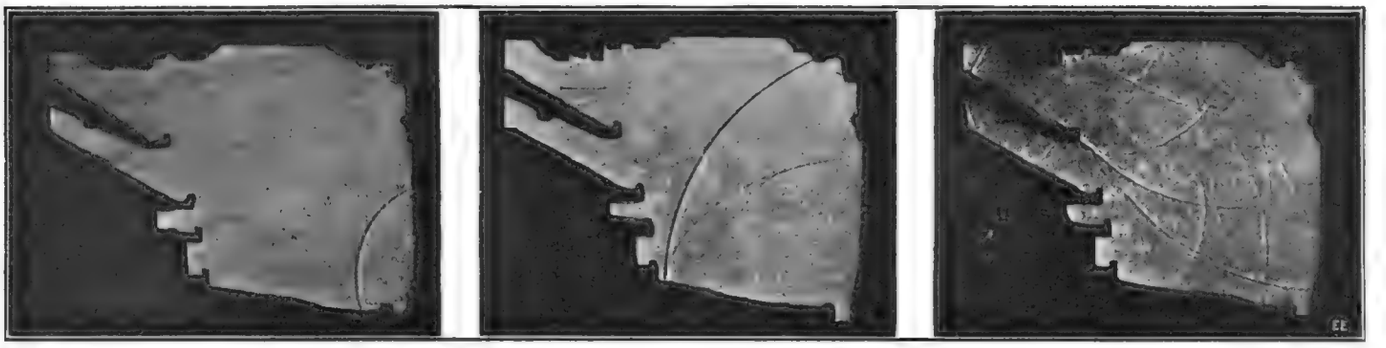
The Science of Sound

SOUND is that mysterious phenomenon of nature by which we are able to communicate intelligence to one another, and by which it becomes possible to accomplish many industrial and scientific wonders, and according to Professor Dayton C. Miller, of the Case School of Applied Science, Cleveland, O., we may define sound as the sensation resulting from the action of an external stimulus on the sensitive nerve apparatus of the ear. In other words, it is a species of reaction to this external stimulus, excitable only thru the ear, and distinct from any other sensation. Atmospheric vibration is the normal and usual means of excitement for the ear. This vibration originating in a source known as the *sounding body*, which is itself always in vibration. For instance, the source of the sound may be constructed especially to produce a certain quality as in a stringed instrument, whether the string is plucked or bowed, and its consequent vibration transferred to the wooden or other sound-board and which in turn impresses the motion upon a larger mass of air.

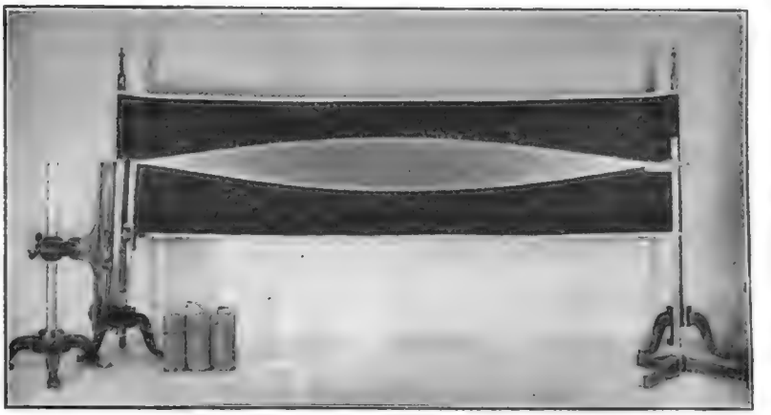
The word sound is used by the scientist to designate the vibrations of the sounding body itself or those which are set up by the sounding body in the air or other medium, and which are capable of directly affecting the ear, even tho there is no ear to hear; the sound going forth just the same.

The accompanying illustrations which we are enabled to present thru the courtesy of Prof. Miller, who is considered a very high authority on the science and physics of sound, illustrate but a few of the hundreds of extremely interesting demonstrations and peculiar devices which have been worked out in the physical study of sound.

One of the accompanying illustrations shows how laboratory apparatus may be set up so as to cause a single taut string to vibrate in a single loop. In taking the photograph of the vibrating string, a black background was provided, so as to show the loop of vibration more clearly. This single loop corresponds to a simple tone consisting of a fundamental only. The string is secured at one end to a stationary support, and at the other to one prong of a special electrically-operated tuning fork. The tuning fork may be adjusted for different frequencies when desired and in general corresponds to the usual musical tuning fork, except that a small electro-magnet is placed between the two prongs. When a battery current is past thru this electro-magnet, it attracts the opposite leg and sets the fork vibrating, the battery current being interrupted at every swing of the tuning fork limbs by virtue of a platinum contact mounted on the vibrating fork. The string may consist of a silk cord.



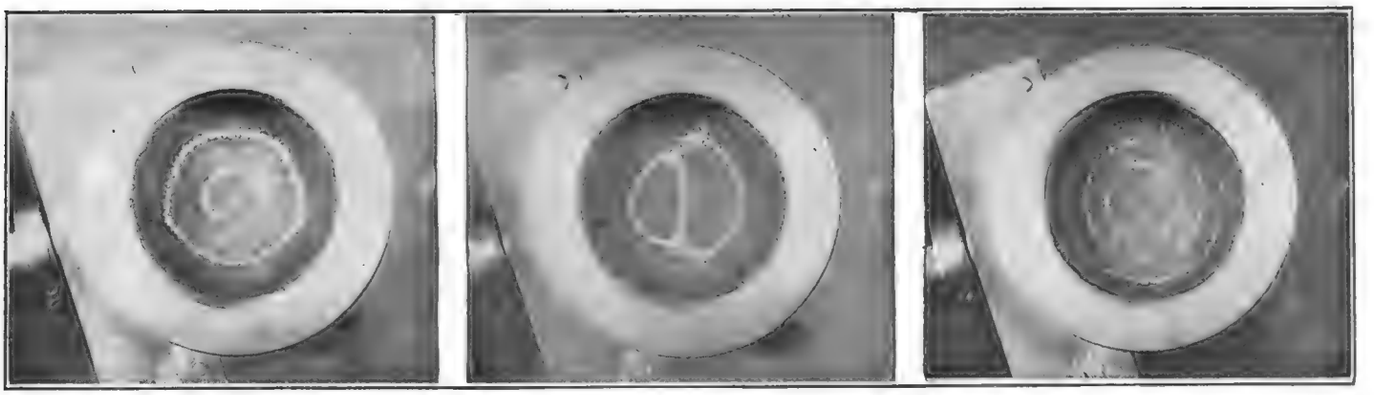
Prof. W. C. Sabine of Harvard University Has Made the Accompanying Remarkable Photographs Showing First—the Start of a Sound Wave Into an Auditorium, (Left). At Center, the Sound Wave Photographed 3-100ths Second After Its Production on Stage. Right—Echoes in a Theater Developed from a Single Sound Impulse in 14-100ths Second, Resulting in What We Call "Reverberation."



Interesting View of a String Vibrating in a Single Loop, Corresponding to a Simple Tone of a Fundamental Only. An Electrically Vibrated Tuning Fork Is Used in This Experiment.

By simply changing the tension of the string so arranged, it can be made to vibrate in various sub-divisions corresponding to its harmonic over-tones. For instance, it may be caused to show two-loop, three-loop and five-loop formations, representing respectively the first, second and fourth over-tones.

One of the most remarkable sound analyzing instruments is Professor Miller's *Phonodeik*. This instrument has been made in several different forms for especially analyzing and studying the various fundamental tones and harmonics of musical and other sounds in the laboratory, but the one here shown is probably of the greatest interest to the layman. By means of the projection type of phonodeik (here illustrated), Prof. Miller was enabled to present some very startling effects in his recent lectures in New York City before the American Association for the Advancement of Science. When the

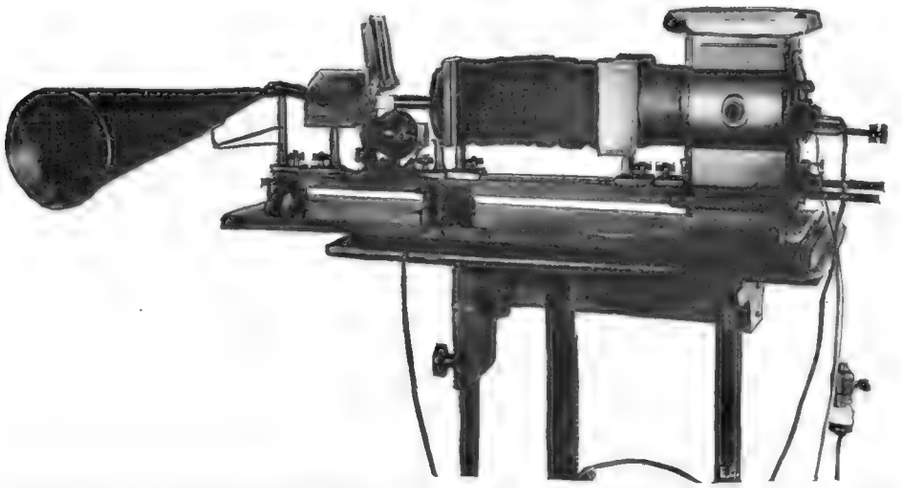


Many Valuable Studies of Sound Waves Can Be Made by Means of "Sand Figures." The Sand Is Placed on a Diafram Which Can Be Vibrated at Any Desired Frequency or Note.

word "War" for instance was pronounced into the horn of the phonodeik, its tiny revolving mirror caused a narrow beam of light to dance wildly on the stage screen, but when the word "Peace" was spoken into the instrument, the light beam smoothed out remarkably, exercising a wonderful and truly remarkable psychological effect on the audience.

The operation of the phonodeik, which is the result of many years' study, is based upon the use of a vibrating diafram, which is placed at the base of the horn shown. The movements of the diafram due to vocal or musical sounds projected into the horn cause it, with its vibrating mirror, to project a tiny beam of light, which falling upon a motor-driven revolving mirror, is thrown on to the white screen on the stage in the form of a long wave. The movements of the diafram are magnified forty thousand times or even more, producing a "light" sound wave on the screen which may measure ten feet in width and even forty feet in length, suitable for a practical demonstration of the physics of sound to an audience of any magnitude.

The projection phonodeik possesses many



The Marvelous "Phonodeik" Devised by Prof. Dayton C. Miller, Which, by Extremely Delicate Electro-Mechanical Attachments, Permits a Lecturer to Project on a Screen the Undulations of the Speaking Voice, Magnified 40,000 Times! Truly a Scientific Masterpiece and An Invention of Far-Reaching Importance and Application.

remarkable qualities, among which we find that, if the revolving mirror is kept stationary the spot of light on the screen moves in a vertical line as the diafram vibrates; tho these movements are superposed, their extreme complexity is shown since the turning points are made evident by bright spots of light. If we turn the mirror slowly by hand, then the production of the harmonic curve by the combination of vibratory and translatory motions is demonstrated. By the aid of a simple tuning fork, the simplicity and wonders of the sine curve are exhibited grafically. By using two tuning forks, it becomes possible to demonstrate before a large audience, the combination of sine curve waves. Also the relations of loudness to amplitude, and of pitch to wave length may be fully demonstrated. As the sound changes at the phonodeik apparatus, the light wave follows in consequence, and the projected image on the screen undulates rythmically, and in a most remarkable manner.

Three interesting illustrations are presented herewith which show the progress of a sound wave in a theater; the wave gradually swelling out into the auditorium until the main wave has reached the back of the gallery and been reflected.

Sound waves, according to Prof. Miller, consist of alternate condensations and rarefactions which are projected thru space with a velocity of 1,132 feet per second (at 70° Fahrenheit), and for the tone "middle C," the distance from one compression to the next is about four feet. It would prove very desirable indeed to be able to actually photograph sound waves in air, but no practical means have as yet been perfected for photographing waves of this size. The accompanying photographs of a cross-sectional model of a theater showing the progress of a sound wave from the stage is due to the researches of Prof. W. C. Sabine, of Harvard University. Photographs such as these, showing the sound wave at any instant, are taken by instantaneous exposures and are obtained by the snapping sound produced by the electric spark discharge from a Leyden jar. The sound thus given off by a Leyden jar discharge consists of a single wave containing one condensation and one rarefaction, the wave length of which may be 1/16 inch or less, and the sound is relatively a loud one. Now if, while such a sound wave is past over a photograph plate in the dark, the wave is instantaneously illuminated by a single distant electric spark, then the light from the spark will be reacted by the sound wave which will then act as a lens and register itself on the plate. The accompanying photographs, due to Professor Sabine, show some of the work carried out by him in studying the problem of auditorium acoustics.

To make such sound wave photographs, a small cross-sectional model of the auditorium is first made. The photograph plate is placed behind the model; the sound is produced on the stage at the right, and the resulting wave is propagated out into the auditorium with a velocity of 1,132 feet per second. The second view shows the period just before the main sound wave reaches the balcony, and the final photo shows the wave 14/100ths second after the production of the original sound on the stage, when the main wave has reached the back of the gallery. It will be noted that a large number of echo waves appear, and which seem to come from many different directions, but which are actually generated by the one original impulse. The multiple echoes continue to develop with ever increasing confusion until finally the sound is diffused thruout the auditorium, when we have the condition known as *reverberation.* This explains the effect occurring in a theater, when we hear anyone say that the singer has such a powerful voice that the music reverberates thruout the auditorium.

A great deal of study can be and has been carried out in the realm of sound studies by means of *sand figures.* These are known as Chladnis' figures, and one of the accompanying illustrations shows three interesting forms produced by certain sounds. A large number of patterns can be formed by the various sounds, and which patterns or figures are always the same for the same note.

As an example of what has been accomplished in this direction, it may be of interest to state that, with a diafram of glass held in circular rings and placed horizontally, the vibrator being attached to the under side; when sand was sprinkled over the diafram, figures were obtained as the diafram was made to respond in succession to each one of eighty pipes corresponding to frequencies from 129 to 12,400. The characteristic nodal lines produced for each frequency were then photographed.

Our long, narrow illustration carrying the continuous undulating sound wave as shown at right is one of the most remarkable records of vocal music ever obtained. It was made in Professor Miller's laboratory, and is part of a record of world-famous opera singers singing the sextette from "Lucia di Lammermoor." The white dots along the edge of the record represent the time periods 1/100 *of a second apart.* The original photographic record of this bit of opera is nearly four times as long as the one here reproduced. The particular section of the record illustrated shows the voice undulations and variations of Mme. Tetrazzini and Signor Amato, *i.e.,* soprano and baritone voices *singing softly.* This particular section of the voice record has a duration of .80 second, and is for a single note.

The Voice Record at the Right Shows the Undulations Occurring When Tetrazzini and Amato (Soprano, and Baritone) Warble a Note from "Lucia di Lammermoor." Each Dot Is 1-100th Second Apart; the Time Period of the Record Shown Is .80 Second and Is for a "Single Note."

TELEPHONE AND RADIO IN WAR-TIME FRANCE.

The French army has perhaps made greater use of all electrical means of communicating intelligence than any other military organization of the present time. The illustrations herewith show a central telephone switchboard at army headquarters and a typical radio station, of which many thousands can be found just back of the battle lines. The telephone, telegraph and radio stations are often located in the basement of a once beautiful chateau or church.

Here We See Two Interesting French War Pictures. At Left—Telephone Switchboard at Headquarters. Right—Radio Station Near the Battle Front "Somewhere in France."

The central telephone switchboard shows how cable lines are brought in from every important army division. By means of the flexible cord and attachment plug connected to the wall telephone instrument seen in the picture, an officer of the commanding staff may instantly ring up any division commander and transmit orders or receive a special report as to the progress of a battle at any certain part of the front.

The head telephone set lying on the table is used to listen in secretly into any line running from the trenches to headquarters. Thus the officer in charge may know at once if unauthorized talk is going on.

But to the radio operator comes a full share of mystery, romance and action. He sits with his head receivers clamped tight against his ears while from out of the boundless ether there comes the news of victory or defeat—the call for reinforcements—messages of every description and from many points along the battle front. Needless to say the military radio operator holds a most important position—an importance which the peace-time operator never even dreams about. In his hands there may lie the difference between life and death for hundreds, even thousands of men. He must not make a mistake and his instruments must always work—so long as his antenna stays up.

TORPEDO NOW USED AS LAMP-POST.

The accompanying illustration shows an odd electric lamp-post in use at Newport, R. I. It is formed of a one-time dangerous torpedo, which was captured in the Spanish-American War. The torpedo has been securely anchored in the ground and the electric feed wires, supplying the lamps at the top with current pass thru the hollow shell. The relative size of the torpedo may be judged by comparing it with the marine standing beside it. Rather an expensive lamp-post, as lamp-posts go, this particular one having cost about $7,000 originally when the Spanish torpedo factory turned it out.

Photo Copyright by Press Illustrating Service.

A One-Time Formidable Torpedo, Captured in the Spanish-American War, Now Serves as a Lamp-Post at Newport, R. I.

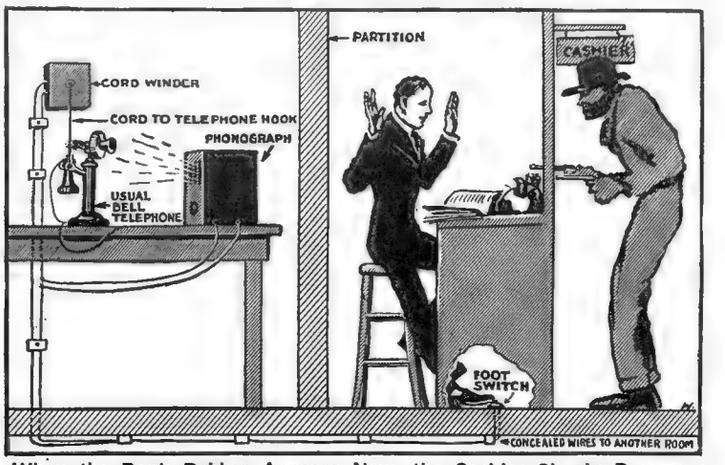
NEW INVENTION 'PHONES POLICE—"THIEF'S HERE."

Burglar detection is made a matter of certainty and simplicity by means of a device invented by Lee A. Collins, of Louisville, Kentucky, Patents are pending on the invention.

With the installation of the alarm, a burglar in forcing or gaining an entrance sets in motion the mechanical device, which then summons the police, giving them the name and address of the person whose home or office is being entered.

Another type of the device does not operate with a phonograph attachment, but instead has a buzzer which warns central, who in turn reports the matter to the police. Another type of the invention has a bell which is controlled by thermostats, and gives fire alarms as well as burglar alarms.

The alarm does not cease if a window or door is closed immediately after being opened, but continues at work until the connection is cut off. The device is simple in construction, and can be attached to any telephone. A special attachment makes it possible for bank or express company cashiers to start the mechanism by pressure of the foot or knee in the event an attempt is made at a hold-up. Two dry cell batteries operate the entire system. If the bank cashier is held up, for instance, he simply obeys orders and throws up both hands if he deems it best, but his foot is busy meanwhile, and when the foot operated trip-switch closes, the Collins automatic telephone alarm immediately gets busy. It raises the telephone hook (in another room, so the thief will not become desperate) and simultaneously starts a small phonograph located near the telephone. It carries a special record, announcing the bank's name, the location and the news that the "thief's here!" It repeats the message over and over again, notifying Central, who at once informs police headquarters.

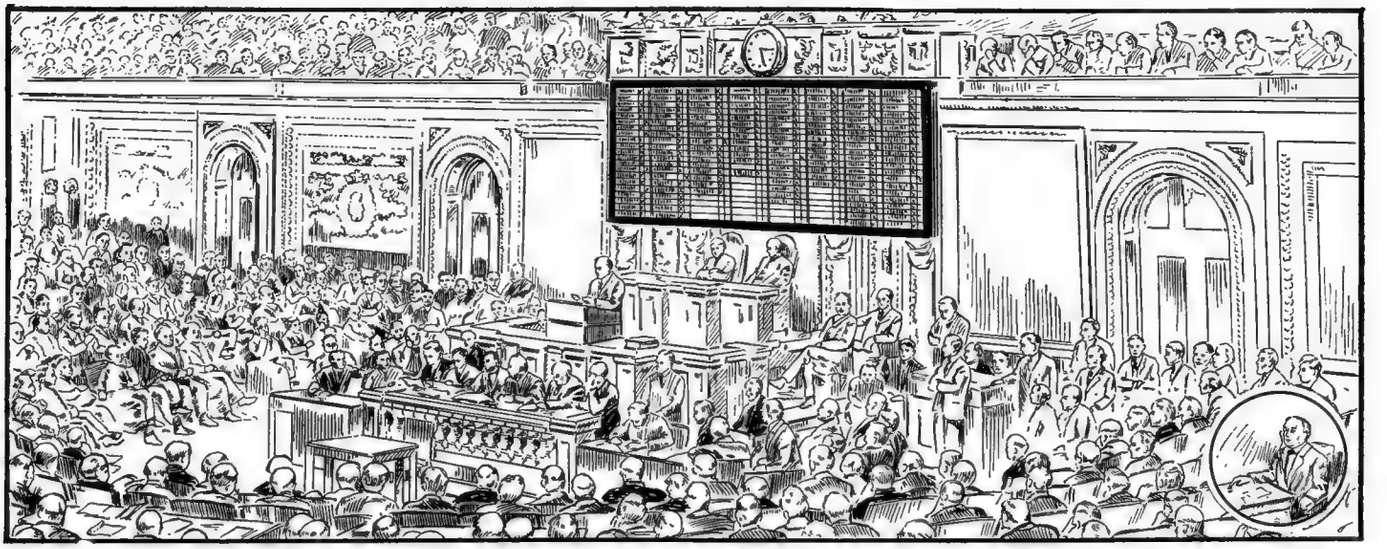


When the Bank Robber Appears Now, the Cashier Simply Presses a Button with His Foot. This Causes a Special Device in Another Room to Lift the Telephone Hook and Start a Phonograph Which Gives Central the Call for Police.

A trap drummer has discovered that electric lights installed inside his drums keep the moisture out and makes the drumheads tight.

The new battleship Tennessee will use 27,500 electrical horsepower, enough power to furnish heat, light and power for a city of 100,000 inhabitants.

Speeding Up Vote of Congress by Electricity



Instead of Wasting an Hour and a Half in Which to "Call the Roll" Alone in the House of Representatives at Washington, a Newly Proposed Electric Voting System Will Cut the Time Down to a Few Minutes, Resulting in a Saving of Thousands of Dollars Annually.

HAVE you ever been present at the roll call of the U. S. Senate or House of Representatives? If you haven't then it is perhaps difficult to realize how much valuable time is lost by calling the roll of such august bodies. Mr. Wilfred Lewis was quite surprised not long ago, as perhaps some of our readers will be now, to learn that it takes generally no less than an hour and a half to get a vote of the House of Representatives, using the tedious and antiquated process of calling the roll. In fact, a favorite form of filibustering in the House is to keep demanding roll calls on every question that comes up, some of them introduced for the purpose. It occurred to Mr. Lewis that in this electrical age some more efficient method might be adopted, and he proposes a far more accurate one, which he thinks might accomplish the same result in half a minute or less. Such a device has been in use in the Russian Duma for years, and presumably there is some reason why other legislative bodies have not adopted it.

Mr. Lewis goes on to say: "It occurred to me while listening to the debates in the House, followed by such interminable roll calls, that a vote on any question had better be 'seen than heard,' that the old maxim should not be applied exclusively to children. The talk, of course, will go on forever, but with a little preparation the vote might be flashed instantly on a screen back of the Speaker in full view of every member and be photographed by an operator in the gallery near the clock. This procedure would require that every member of the House have a lock-box in front of his seat which, when opened, would cause his name to appear in a certain space on the wall or screen. When a vote was called for, he would press a button showing 'Yes' or 'No' opposite his name, or simply vote 'present' by doing nothing. The number or title of the bill would be displayed at the same time; and if the record was illuminated, it could be quickly photographed.

"I believe the time will come when all legislative bodies will be equipt for voting in this expeditious way, and that the same method will be adopted by engineering and other bodies that have no time to burn.

"You can readily estimate the cost of the voting done by 500 or 1,000 high-priced men day after day and year after year in the present absurd way. The cost of installing effective voting machinery in Congress might be considerable, but it would soon be saved at the rate of perhaps $2,000 an hour in the cost of legislation; and more time could also be given to the consideration of the bills presented."

The illustration we present herewith shows President Wilson addressing a joint session of Congress in the hall of the House of Representatives, with an automatic electric vote-recording bulletin, as suggested by Mr. Lewis, mounted on the wall above the Speaker's chair.

The U. S. Signal Corps Wants You!

FOR the information of all applicants in Signal Enlisted Reserve Corps, we give below the general plan of the training and preparation the new units of Signal Reserve Corps are to receive before they are fitted for work in connection with other arms of the service.

"In the first place," says Major Carl F. Hartmann, of the New York Headquarters, "we have attempted to enlist only such men as are technically qualified to carry on the usual functions of the Signal Corps without additional technical training. We expect to give them additional training concerning the use and operation of equipment directly pertaining to Signal Corps Battalions, also an intensive course of military training which will make our organization an efficient military unit for active service.

"Our advice to men who enlist is to continue their ordinary pursuits until they receive the call from the President, then report immediately to the place designated. In the meantime it will be well for them to notify their employers that they will be subject to the call of the President, and must leave his employ when they are notified, otherwise their status with him will be the same as it has been formerly.

"Equipment for all men enlisted, such as uniforms, bedding, messing utensils, etc., will be available for issue at the camps of instruction. Each man enlisted will from the time he reports receive the same pay and allowances as the corresponding grade in the regular army. They are also entitled to transportation in kind and commutation of rations at 50 cents per meal for the time of actual travel from their homes to places to which ordered for active service. If transportation in kind is not furnished from their homes to place ordered for active service, they are entitled to reimbursement for the actual necessary cost of such transportation.

"The term of enlistment is for four years. However, the President of the United States has stated that the Reserve Corps will be held in active service only during the period of the emergency.

"It is proposed, in the Eastern Department, to organize ten (10) Field Battalions, Signal Reserve Corps, and the proper material for these organizations appears to be scarce.

"These Battalions will require men who have technical ability. Most of all, we want operators, both Morse and Continental. In addition to operators, men must be obtained who have had technical training, or who have had an education which will enable them to quickly grasp the mechanical and electrical work incident to the operations of a Field Battalion Signal Corps in active service. The men must, in addition to above qualifications, be strong and athletic, and preferably horsemen.

"A Field Battalion of Signal Corps is an organization for which college and technical men are especially adapted. The work is active and interesting. It is necessary everywhere, on the battlefield as well as on the lines of communication to the bases. The Signal Corps' drills involve the principles of nearly all the other branches of the Army, in addition to the interesting apparatus necessary for the transmission of information. We are prepared to follow the cavalry at whatever gait they desire to take. We work in conjunction with the artillery, and the infantry rely on us for their information. The Signal Corps has been termed the "Nerves of the Army," and is a very necessary branch of the service. At this time, due to the unusual expansion of the Army, promotion should be rapid

(*Continued on page* 214)

"Ham" Jones—Scientist

By HARLAN A. EVELETH

HENRY ALFONSO MARMADUKE JONES, alias "Ham" Jones, was a youth of seventeen summers, awkward and lanky, with auburn hair and freckles, and blue eyes which imbibed the beauties of nature—several sat near him in "Latin 1"—thru the lenses of omnipresent, iron-rimmed spectacles. "Ham" was *some* boy. He had attained a wide reputation among his fellow students as a wizard of wireless telegraphy and as an authority on all the intricacies of "hook-ups" and electrical phenomena pertaining thereto; in fact, the pages of his "Caesar" housed innumerable and priceless diagrams of diagrammatic data, while a rear view of this assemblage of students disclosed the existence of a secret service system of communication whereby others who desired information of a technical brand could obtain the same direct from the hand of the renowned scientist, "Ham" Jones. Thus it was with a great feeling of joy and expectation that I, a humble member of the secret service organization, accepted the magnanimous invitation of "Ham" to devote an evening of my leisure time among the electrical paraphernalia of his far-famed laboratory.

I ascended the steps of the front porch of "Ham's" abode with faltering steps that memorable night, and I pushed the push of the push-button with the end of an ink eraser; for I had heard rumors of "big sparks" and unexpected shocks, and rubber is an insulator—"Ham" had told me so.

"Hello! 'Spin'," quoth "Ham," as he swung the door open. "Glad to see you! Come right in and make yourself at home." And with that he gave me the "glad hand" and a pat on the shoulder.

"The pleasure's all mine!" I replied; I, alias "Spin" (short for "Spindle") being modeled somewhat along the graceful lines of a Geissler tube.

"Come right up stairs," chirped "Ham," so I trailed along behind him, up two flights of stairs to a hall leading to the laboratory in the attic.

"Ham" turned on a light, and thereupon my eyes opened wider and wider as I gazed in mingled awe and ecstasy upon the vast accumulation of multifarious electrical equipment which adorned the four walls and portions of the ceiling and floor of the laboratory; a bewilderment of coils of wire, switches, bells, insulators and instruments of every type and form imaginable—and surmounting the whole, a crudely lettered sign bearing the ominous warning:

"... He Picked Up a Fine Wire from the Floor, Fastened It to the Coil and Prest the Key. Suffering Cats! ! ! My Shoes Became Full of Carpet Tacks and I Leapt so High that My Head Nearly Hit the Ceiling. ... 'Hen' Got to Laughing so Hard He Could Not Keep His Stick on the Key."

"There's my room, you can open the door and step right in," gurgled "Ham." "I left something down stairs, I'll be back in a moment."

"All right," I said, innocently, and then grasped the knob of the door. I had pushed it about half open when the knob suddenly turned red-hot, or something, and it would not let go of my hand for all I could do to persuade it to. "Ham" stood on the stairs, with his hand beneath the railing, and laughed so hard that he finally sat down on the steps to keep from tumbling the whole length; thereupon the knob turned "cool" and I yanked my hand away.

"You big boob!" I yelled, for I was scared and about ready to choke. "Do you want to kill a feller?"

"Aw forget it. You have to get used to shocks if you're going into the wireless business."

"Yes—well, will you let me try it on you?"

"Perhaps, later on, but I've got lots to show you—and besides, it's a waste of 'juice.' Come in and I'll show you my junk." So in I went.

DANGER!

150,000 VOLTS
All Persons Entering This Laboratory Do So At Their Own Risk

"Hen," I said, in a plaintive tone, as if about to ask him for a job. "I guess I'll stand over near the doorway." I was careful to call him "Hen", for I feared dire consequences if I should offend his dignity.

"No, you stay right where you are," he retorted. "There will be no danger as long as you keep your hands off the wires."

"But how about those 150,000 volts?"

"Don't you worry about them. They are Tesla coil volts, and they won't do more than knock you down. I'll save the fireworks for the last, so that if you get killed you won't miss any of the show."

"Uh huh!" I gasped; then wondered if I had not better make a break for the door while I had the chance.

"Take a seat," said "Ham," "and I'll show you the wireless." So I gingerly took a seat, after first turning it upside-down to discover the presence of any diabolical mechanism which might be concealed in the cushion.

"Now, 'Spin'," he said, with a wave of his hand, as he assumed a professional attitude, "that apparatus over there on your right is called the transmitting set. It is hard for me to explain the function of the various instruments in terms which will be understood by the layman, so I'll try to use simple language. This instrument here is called a transformer, and it takes the 110 volts and cuts them up into pieces until there are fifteen thousand volts. That is thirty times as many volts as run the electric cars, so it is a very dangerous current to fool with. From the transformer the volts flow into this condenser, which piles 'em up like sardines, until there are so many that they jump across this spark gap. That coil of wire is called a helix. The volts get going around it so fast that some of them shoot off into the aerial, and from there into the *ether*. That's about all there is to it. The code is made by punching this key."

"That's a pretty complicated affair, all right," I ventured to say, "but there's one thing I don't understand. What do you mean by saying the volts go into the ether? I took ether when I had my arm broken, but I don't see what it has to do with wireless."

"Haw! Haw! The wireless ether is not a liquid, it's a substance, er——'inconceivably attenuated which is supposed to be coextensive with infinite space.' That is the only way I can describe it. I don't know much about it myself. However, these instruments over here are for receiving. The messages come down the aerial, and then pass thru those tuning coils, the receivers and the detector. The detector lowers the rate of vibration of the incoming current so that you can hear the signals, while the tuner regulates the wave-length."

"I think I understand, but can I hear a message?"

"Sure thing! I've got two, good (get that), one-hundred-ohm receivers and we'll have one apiece."

We clamped the receivers on our head, and "Hen" monkeyed with the switches and the detector and slid the contacts up and down the tuning coil as if he was sawing wood, but the only thing we heard was the test buzzer.

"There must be a loose connection somewhere," explained "Hen", as he made a minute examination of the wiring. Finally we heard a series of loud buzzes which suddenly broke into a long dash. "Hen" worked the tuner for all he was worth, but could not tune the station out.

"There's no use trying, it's another one of those *Hams* who sits on his key for the pleasure of hearing his spark. Those fellows make me sick; they have a habit of doing it just as I start to listen to——" Just then "Hen" lifted his elbow and the noise stopt. He didn't say a word; just looked a bit foolish and sawed his tuner harder than ever. Finally he jumped up, stuck his head and arms out of the window and did something which suddenly made the buzzes come in at a great rate.

"I guess that's one on me," said "Hen." "I forgot to open the ground switch. Now listen. Ah! There's Colon—keep quiet now, don't talk—hang it all, there's that fellow who sits across the aisle from me in Latin one; he's always butting in on me when I am trying to do long-distance work—listen! There's the 'R. B.' giving her 'O. S.' to 'B. H.'—Hear that low spark? That's 'H. A.' shooting the baseball scores. Gee! I wish I could copy him, but I can't, he's using Morse. I guess you have heard enough. Take the receivers off and I'll go on with the show."

So I did as commanded, thanked him for the demonstration, and told him, in earnestness, what a remarkable person he must be to comprehend the technique of such complex mechanism.

"Say, 'Hen'" I inquired, noticing the contents of a box reposing in the corner, "where did you get all of those fuses?"

"Fuses? Those are all burnt out. I bought them at a nickel apiece, and there's about two dollars' worth there in the box. I threw another dollar's worth away last night at a couple of cats. About a week ago 'pa' served me with an ultimatum to the effect that I was to buy no more fuses, so I have hit upon a scheme whereby they won't burn out so easily. I take the top off a burnt fuse and fill it with tin-foil, then force it back onto the fuse, and behold, I have a new fuse which lets more current thru than it did when new! You need not tell anybody about it, for I am thinking of getting the idea patented."

ARTICLES IN THE AUGUST "E. E."

We have a number of fine things in store for the August issue of THE ELECTRICAL EXPERIMENTER. *Among the 125 articles already scheduled for the August number the Editors take pleasure in annquncing the following:—*

"The Unsinkable Ship"—A solution to the submarine problem by Hiram Maxim himself. A feature article of the highest class.

"The Radio Bomb"—A thrilling wireless story that will keep you guessing every minute by C. M. Adams.

"Standard Time"—In which our friend, Thomas Reed, discourses in his inimitable style on the use of spider webs and electricity in checking standard time. Don't miss it—Readers.

Selenium, some new electrical and scientific aspects of this little known substance by Albert W. Wilsdon.

The Marvels of Radio-Activity. Part II by Jerome S. Marcus, B. Sc., (Ch. E.)

A Home-Made Arc Searchlight for the Amateur by Frank M. Jackson.

An Electrolytic Interrupter for Low Voltages by C. A. Oldroyd.

Making An Electric Clock by Thomas Reed.

The Present Status of the Audion by Dr. Lee de Forest.

Complete Details for Building a 20,000 Meter Undamped Radio Receiver by Wm. Burnett, Jr.

Amateur and Experimental Radio Research. Part II by Raymond Francis Yates.

"That is a good scheme, all right," I remarked. "I will say nothing about it; but what is that arrangement over there on the wall?"

"That is a little contrivance of mine whereby I am enabled to listen to conversation which takes place on the first floor. It consists of two microphones, a battery and a telephone receiver. I installed the microphones last Sunday when the rest of the family were at church; one is located behind the boiler in the kitchen and the other beneath the radiator in the parlor. Hold the receiver up to your ear and see if you hear anything."

"Yes," I said, "I can hear people walking around. Keep quiet a moment." The hissing and scraping noise gradually died down, and then there came to my ear a series of distorted words to the effect that ". . . I am sick and tired of the company which Henry continually brings to this house . . . they are a nuisance . . . . he is failing in his Latin . . . some night . . . throw his old wireless out of the window . . ." Whereupon I dropt the receiver and said to the unsuspecting "Hen," "It's getting pretty late. I think I had better go home."

"Hen" urged me to stay. "I will now show you the Tesla coil. I can't operate it very much in the evening, for it blinks the lights and is apt to cause trouble in the family." He tinkered with the switchboard, made new connections, then prest the key with a yard-stick and blandly continued, "The sparks I am about to show you consist of over one hundred and fifty thousand volts. They electrocute men over in Sing Sing with two or three thousand volts, so you can imagine what a dangerous current this is. That's it," as I backed away, "stand on the rug there and you will be safe." "Ham" Jones punched the key with his stick and long, purple sparks shot off from the knobs of the Tesla coil, flicked about like the fangs of a boa constrictor and snarled and crackled like a wounded "rattler." I stood on the rug in mute admiration of this exhibition of artificial lightning, ever fearful of an impending death. "Hen" let the sparks play over his hands and even pulled sparks from conspicuous portions of my anatomy. Surely, he was a genius, a second Edison, a great engineer to be; I told him so, but he only laughed and told me to wait a moment and he would show me something better. He picked a fine wire up from the floor, fastened it to the coil and prest the key. Suffering cats!! My shoes became full of carpet tacks and I leaped so high that my head nearly hit the ceiling; then down I came again on that red-hot carpet, and thus I danced in agony until "Hen" got to laughing so hard that he could not keep his stick on the key. I was mad clean thru, but what could I do with "Ham" leaning against the wall, so merry that the tears fairly rolled out of his eyes?

In about ten minutes the "Wizard" regained his former dignity and proffered an explanation of his ingenious trick. "Underneath that rug on which you so kindly stood," said he, "are a couple of square-yards of chicken-wire. I connect it with the coil by means of this fine wire, whenever I desire to pass the spark into the feet of whoever is standing on the rug. It works better on the ladies, for the soles of their shoes are not as thick as men's. I worked it on our Parson the other day, and the sermon I got from 'pa' a few hours later was sure brief and right to the point."

"'Ham'—er, 'Hen,' that's a pretty clever stunt, even if I was the goat," I ventured to say. "Those big sparks of yours are more interesting than the wireless, but I don't understand the peculiar way in which they seem to work. I don't see why they should jump into my feet when I do not have a second connection——"

"Of course you don't," interrupted "Hen." "I can't explain the reason in simple language. Now if you will step over here near the bed I'll show you some more interesting ideas. Before retiring I pull the shade, shut the door and turn on the electric light. All three of these are arranged to be worked electrically from a series of push-buttons located near the head of my bed. Step over here and I'll show you how the curtain works."

(*Continued on page* 217)

20,000 Volts Direct Current

When a sufficiently high potential difference is imprest between two parallel wires, or a wire and concentric cylinder, separated by air or some other gas, this gas which for low potential gradients is a very good insulator breaks down and becomes a partial conductor. The phenomena connected with this character of conduction thru gases are known collectively by the name *corona*. The failure of the gaseous dielectric separating the metallic conductors is made evident by a flow of current from one conductor to the other, by a power loss and, in practically all cases, by the appearance of light at either one or both conductor surfaces. In some cases light appears in the intervening space.

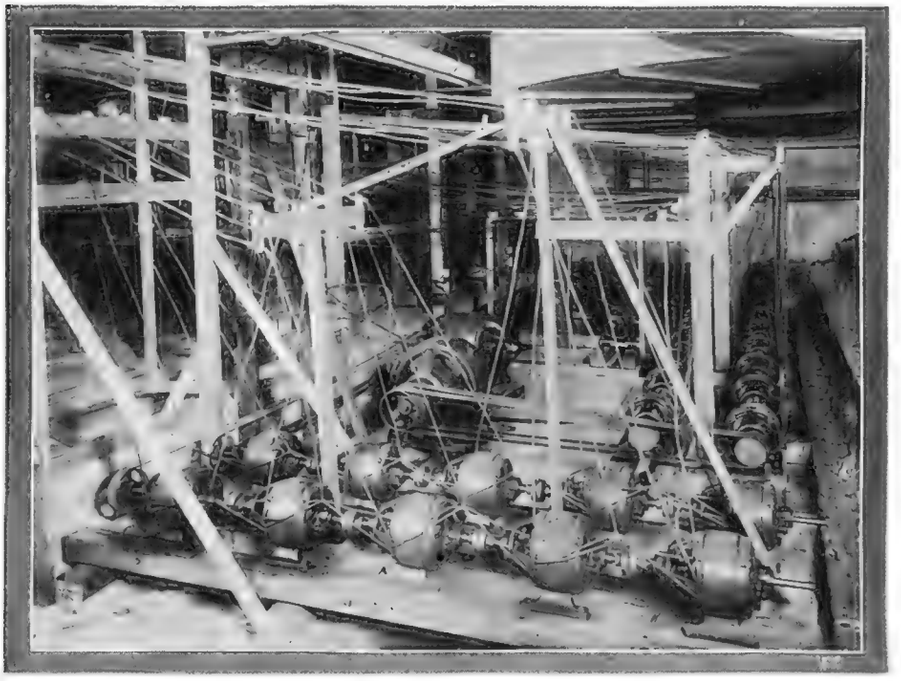
Since the present theories as to the mechanism of corona formation do not satisfactorily account for all of the observed phenomena it was decided to carry out further investigations, says G. W. Davis and C. S. Breese in the Proceedings of the A.I.E.E., in the hope that when enough data were accumulated some theory based on fundamental principles and explaining the observed phenomena might be evolved. With this purpose in mind it was attempted to simplify the conditions of corona formation.

A wire and concentric cylinder were used in order to make the field radial and to get away from the secondary effects due to the high intensity electric field surrounding a second wire. Hydrogen was used as the dielectric in order to minimize the effects due to changes in the chemical constitution of the gas. When air is used as the dielectric the formation of ozone may produce marked changes in the voltage necessary for corona formation. Continuous potential was used in order to separate the effects accompanying a discharge from a positive wire to a negative tube from those which are characteristic of the discharge from a negative wire to a positive tube.

The continuous (direct current) voltage used in these investigations was obtained by means of a battery of forty 500-volt, 250-watt, continuous-current, shunt-wound, generators connected in series.

These machines are divided into two sets of ten machines each and one set of twenty machines, each set being driven by a belt-connected continuous-current shunt motor. The generators are mounted on insulating bases and the shafts of the separate machines are connected by insulating couplings. In the newer part of the installation one terminal of each machine is permanently connected to the frame of that generator, in order definitely to limit the strain on the machine insulation to the voltage generated in one armature.

The field of each machine is connected directly across the armature terminals, a single-pole knife switch being included in the circuit in order that the machine may either be made to generate or to run idle at will. These switches were operated by means of a hard rubber rod approximately eighteen inches in length, since they may be 20,000 volts above earth potential. The generators were run somewhat below rated speed in order to limit, to a safe value, the voltage generated with no external resistance in the field circuit.



One of the Most Remarkable Electric Generating Plants Ever Built. It Is Used for Special Test Work and Comprises Forty 500 Volt D.C. Dynamos, Which, All Driven and Connected Together, Develop 20,000 Volts Direct Current!

READING BY WALL PAPER IS THE LATEST INVENTION.

Two-wheeled automobiles and torpedoes with mechanical ears to chase ships by sound waves are brain products of Professor Montraville M. Wood, who gave a demonstration of his inventions at the Union League Club recently.

By radioactive paints he asserts an expensive mural decoration may be manufactured which will furnish so much light a person may read by it.

"Within ten years," he said, "there will be plenty of nonskidding automobiles running on two wheels, built on the principle of the monorail and retaining their equilibrium by means of the gyroscope."

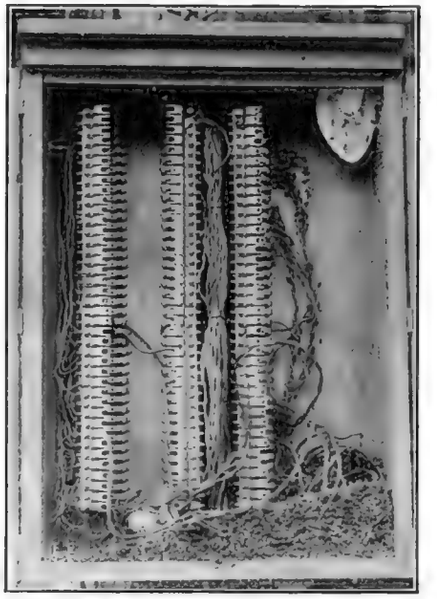
The "listening torpedo," of which Professor Wood is the inventor, is fitted with delicate mechanical devices which record the sound waves made by a ship's screw and draws the torpedo in that direction.

SEVENTEEN PICK UP FALLEN WIRE.

The curiosity of the human race knows no limit. In one of our large Eastern cities, says the *Au Sable News*, some men were at work installing a new wire on a busy street. For some reason the part of the wire that was already in place broke near one of the poles and fell to the ground. As the work of erection was not yet completed, the circuit was not in service and the wire was dead—but this fact was known only to the employees of the electrical company. One of the men, knowing the danger to the public from fallen wires, but also knowing that this particular wire was harmless, stood near by to note what action the passing throng would take. In fifteen minutes approximately 200 persons past this point, and of this number twenty-two showed some curiosity regarding the wire. Of the twenty-two who stopt seventeen, all adults who might reasonably be supposed to know better, stooped down and took hold of the wire, or at least touched it, and then, finding it harmless, past on. If the wire had been charged to a high potential, the first of the seventeen "doubting Thomases" would have been killed.

HOW BEES BECAME INTERESTED IN TELEPHONY.

If C. W. Weston, manager of the Port Byron (New York) telephone company, had been in the honey business he might have welcomed the visit of a full sized swarm of bees which took refuge in the company's terminal box located on the main street of the village. After taking council with the local physician and druggist, and receiving no satisfactory advice, Mr. Weston's mind wandered back to the old days on the farm where on one occasion he had been compelled to test conclusions with several skunks. He procured some bi-sulfate of carbon and with it saturated a handful of cotton waste and packed it in every aperture of the terminal box. A careful and cautious examination was made the next evening, when it was found the deadly fumes had done their work. The accompanying cut shows the dead bees. Note the comb started in the top right hand corner.



Bee-lines and Telephone Lines May Not Have Any Common Bond Existing Between Them, But These Bees Evidently Thought So As They Calmly Proceeded to Build a Home In a Telephone Cable Terminal Box at Port Byron, N.Y.

A COMPACT ELECTRICAL HOSPITAL.

Electro-therapeutics is steadily claiming the attention of the present-day electrical engineer, owing to the rapid strides being made in this field, competition acting as the all-important stimulant.

A Remarkable Electrical Outfit of Extreme Compactness Which Yields Practically Every Form of Current the "Doc." May Require. It Is Rated at 5 Kilowatts.

Formerly, the electrical laboratory of the physician was littered with various apparatus, of no real consequence save to occupy space. But these conditions have been rapidly overcome, and to-day we find that the modern physician insists on his apparatus, where electricity is employed, shall be as compact and yet as complete as possible. Various equipments have been devised and introduced but none of these compare with that illustrated herewith which was designed and built by Harry Rosenthal, an electrical engineer of New York City.

The applications of these instruments are numerous a few of which are here mentioned: X-ray work, high frequency, Tesla and cautery currents of all intensities, Ozone generation for liquid saturation; apparatus for the production of mechanical vibration and air suction for skin treatment; also, the apparatus for the production of a remarkable new therapeutic ray, namely, the Rosenthal R-ray.

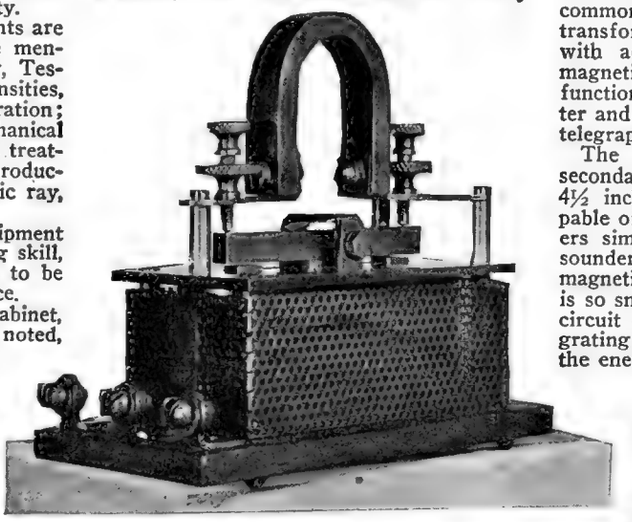
The construction of such an equipment requires a fine degree of engineering skill, considering the numerous apparatus to be fitted into the smallest possible space.

Commencing at the top of the cabinet, the two X-ray terminals will be noted, which are used to connect with the X-ray tube. A milliampere meter is stationed on the left, which is used for measuring the current sent thru the tube when in operation. The control switch-board consists of two white marble panels. Various binding posts are placed in front of the panel, each pair being used for a definite purpose, and the connections are made thru flexible copper conductors. Levers and switch arms are stationed about the panel suitable for controlling the many kinds of currents supplied. The two ball posts at the extreme right hand are used for connecting the apparatus used in the production of the X-ray. Each pair of terminals are controlled by an individual switch. Apparatus for applying the generated ozone may be seen in the upper left corner, and this consists of a special glass tube fitted with a fine nozzle.

The generating and main instruments are contained in the lower portion of the cabinet. A motor-driven suction pump is utilized for the production of mechanical vibration and the device which is applied to the patient is noted on the left side of the cabinet. It consists of nothing more than a rubber tube placed in a special receptacle and connected to the pump by means of another rubber tube. A second pump is used to force out the generated ozone. This is made in a glass tube hung on the door of the cabinet seen at the right. The terminals are connected to the high frequency circuit by means of brass clips when the door is closed, while the ozone is past thru a rubber tube to the pump, and finally to the glass bottles as above mentioned. Four high tension condensers are employed and these are placed in each corner of the lower compartment. The Leyden jars contain salt water as the interior coating, and connection is made thru a carbon rod. The Tesla transformer is placed on the door of the cabinet and its connections are terminated at copper jaws which interlock on metal lugs when the door is closed. The high tension current is supplied by a 5-kilowatt closed-core transformer and this is placed in the base of the cabinet. Its secondary terminals are led to a special rotary spark gap which is placed in the rear.

A TELEGRAPH SOUNDER THAT WORKS ON A.C.

Telegraph sounders all operate on direct or continuous current, such as that from a battery. But here is one that clicks away at a merry pace on alternating current! In brief, the current from the line thru the main line relay keeps the armature normally against the front contact, permitting current from a small alternating current transformer to energize a winding on a laminated iron core. On opening the main line and consequent demagnetization of the relay the armature makes contact with the back stop, thus energizing one coil of the transformer. The sounding lever of the transformer, fulcrumed on the center or common leg of the laminated core of the transformer, is alternately held in contact with adjusting screws kept continuously magnetized by a permanent magnet. The function of the magnet is to prevent chatter and hum of instrument and renders the telegraphic sounds uniform.



Something New In Telegraph Sounders—One That Actually Works Efficiently On Low Voltage Alternating Current From a Step-down Transformer.

The small transformer case (including secondary voltage regulator) measures 3x6x 4½ inches high. This transformer is capable of operating fifteen or twenty sounders simultaneously. Energy taken by the sounder is approximately four watts; the magnetizing energy taken by transformer is so small that the primary may be left in circuit continuously, as the ordinary integrating watt hour meters will not indicate the energy consumed.

The function of the contacts on transformer is to adjust voltage to best operation of sounder. Under proper conditions it is practically impossible to tell whether the sounder is connected to an alternating or direct current circuit. A trial equipment in a railway telegraph office has operated successfully on a sixty cycle circuit, but the device operates equally as well without any change on twenty-five cycles. A loud, clear sound is obtained by a movement of but 5/1000 inch of the lever.

A NEW TELEGRAPH TEACHING MACHINE.

The instrument here illustrated is intended to simplify the details of telegraphy. It is operated without the aid of an instructor. All that the beginner has to do is to follow the chart and execute the dots and dashes as they are printed thereon. It was invented by Mr. George J. Little and is called the *Simplograph*.

The object of having a key for each letter is to allow for the use of both hands simultaneously if desired. This gives the beginner plenty of finger exercise. This instrument is claimed to represent distinct advantage over the single key or other mechanical devices that are now on the market. A dry cell or two, connected up to the keyboard here shown, causes the buzzer mounted thereon to respond every time the keys are deprest. Incoming signals are received on the buzzer also. The key before each letter on the chart must be deprest the proper number of times for the corresponding dots and dashes. The device should prove of value to students.

The "Simplograph"—An Attempt to Make the Learning of the Telegraph Code as Simple as Possible. A Buzzer Sounds the Signals for Radio Students.

A 36-INCH SPARK TESLA COIL FOR LECTURERS.

Probably the most amazing and spectacular of all electrical apparatus is the Tesla or High Frequency Coil and no electrical

3 Kilowatt Tesla Coil in Full Activity, Giving 36 Inch Sparks. The Sparks May Be Taken Into the Body as Their Ultra-high Frequency Renders Them Harmless. This Is the Class of Apparatus with Which Our Pseudo-professors of the Stage Are Wont to Over-awe and Mystify Us.

laboratory or lecturer's outfit is complete without such an equipment. It is most astonishing to be able to draw coiling, flaming sparks from a few inches to several feet in length from your body to the coil without the slightest injury or discomfort. Hundreds of other interesting and strange experiments may be performed, such as lighting large numbers of vacuum or Geissler tubes of various brilliant colors by merely holding them in the hand near the coil without any wires whatever. The ordinary incandescent lamp will glow with a pale green light when held near the coil or connected to it. Various minerals and many precious stones will glow and fluoresce with unusual lights and colors under its influence. Its sparks when occurring over large flat areas produce a large quantity of ozone. A wire bent in the shape of the letter "S" and balanced on the point of a pin from its center, will rotate as a static motor with flames shooting from its ends when the pin is connected to one pole of the machine. All of these experiments and hundreds of others may be performed without the slightest danger, as the frequency of the current is so high as to render it harmless. You cannot even feel the spark if it is allowed to jump to a piece of metal held in the hand, but where the spark jumps directly to the skin it gives a slight pricking sensation only on the spot where the spark strikes. The coil has a movable contact on the primary for tuning it to the secondary. Proper tuning between primary and secondary is important for satisfactory results.

The Tesla Coil rated at ¼ K.W. will give a purple flame about 9 inches long when operating in proper tune or resonance, and when the electrodes are separated to a greater distance each is surrounded by a fan of coiling sparks several inches in length. It requires a condenser of approximately .01 M.F.

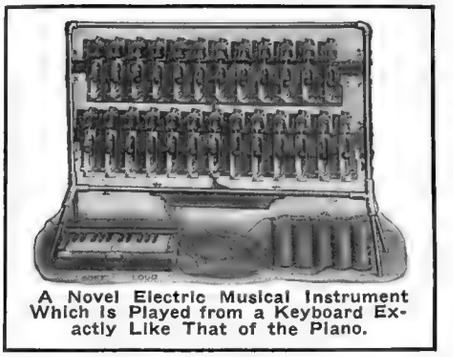
The coil shown in full activity is producing 36-inch high frequency sparks and is excited with a 3 K.W. radio transformer, a spark gap and a high-tension condenser of .03 microfarad capacity. These outfits operate from 110 volt, 60 cycle A.C. circuits and form an excellent apparatus for the lecture and stage platform.

ELECTRIC UNA-FON MAKES MUSIC TO BEAT THE BAND.

The electric Una-Fon here illustrated is played from a keyboard, the keys of which are exactly the same as those of a piano. No previous experience is necessary for its successful use and any piano selection can be played on it, both harmony and melody. The instrument is said to mark a new departure in tone quality, it having been likened by some to the *Vox Humana* of a pipe organ. The Una-Fon may be played either soft or loud and is equally adapted to use in theater or in the open. In street work, under fair conditions, it may be heard several blocks; it has wonderful volume and carrying capacity. On the water its clear, brilliant tone carries great distances. The maintenance expenses is kept at a low figure by reason of the storage battery supplied with each set, cutting the operating cost down to two or three cents an hour.

Each tone-producing unit is a patented special alloy, nickel plated, concave steel bar, mounted over a special resonator on a solid oak frame, with an electric playing action attachment. It remains in perfect adjustment, produces a fast vibrating stroke and wields a large composition mallet that brings out the full beauties of the tone. The instrument is not affected by atmospheric conditions, and retains its tone at all times.

The various electric actions are firmly



A Novel Electric Musical Instrument Which Is Played from a Keyboard Exactly Like That of the Piano.

mounted on solid oak cross-pieces on nickel plated floor rack that occupies minimum space and can be moved anywhere. The keyboard is connected thru a ten-foot flexible cable.

electric musical instruments such as the Xylophone, Marimbaphone, etc., as these can be played from the same keyboard.

The third unit of this instrument comprises a small, light battery case for holding dry cells of standard size, which is constructed with fastenings so that it may be attached to any part of the machine that is found convenient. The three parts of the apparatus are connected by a single cable, of such length that the whole apparatus can be instantly attached to any of the standard instruments now in use.

RADIO IN DENMARK.

Denmark has organized at Svenborg a school of radiotelegraphy with the object of giving complete professional instruction allowing pupils to obtain the necessary certificate to operate wireless stations.

LARGEST STORAGE BATTERY IN UNITED STATES.

The Detroit Edison Co., has in service in its Congress Street Sub-station the largest storage battery in the United States.

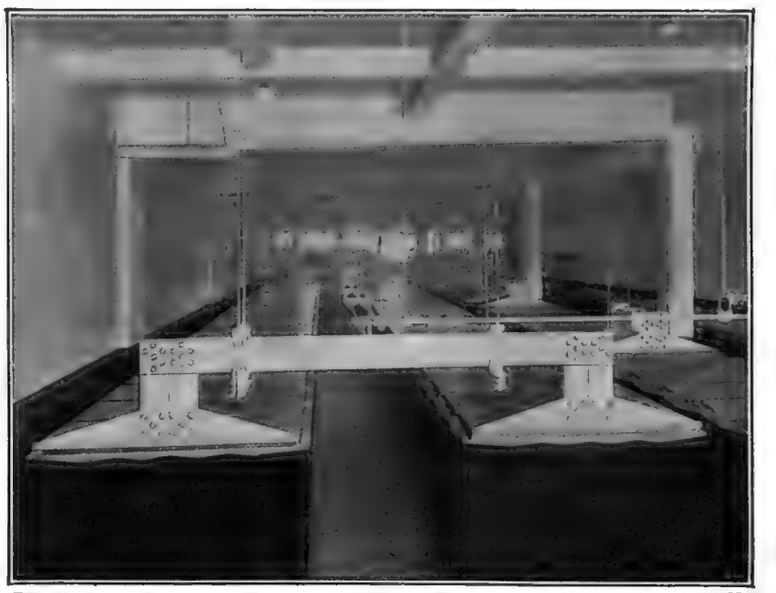
This installation is of interest, not only on account of the high capacity of the battery but also as showing the most recent practise in storage battery engineering as applied to urban direct current lighting systems.

This battery is kept fully charged and connected to the bus bars at all times in order to insure against an interruption of service. In case of failure of the customary sources of energy the battery is instantly available for use.

The battery consists of 150 large Exide cells having a capacity of 25,200 amperes at 110 volts for one hour and 80,000 amperes for ten minutes.

Elaborate endcell switches and battery control switchboard are employed for properly switching in the cells, charging them and regulating the counter electro motive force of the battery.

Many of the largest central power stations are equipt with storage batteries similar to this one, for the purpose of helping to carry the *peak* load, which may last only an hour or so, and which does not warrant the installation of additional dynamos to carry the mean average load, plus the peak load.

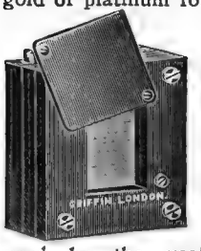


The Gigantic "Standby" Storage Battery of the Detroit Edison Co., Said To Be the Largest Storage Battery in the United States.

Special octave couplers produce a twenty-piece brass band volume. The detachable keyboard enables the addition of other

GRAFITE-SELENIUM CELLS.

The new type of Selenium Cell here illustrated and brought out in England, possesses distinct advantages over all former types, chiefly owing to the use of the non-oxidizable grafite in place of copper, gold or platinum for the electrodes bridged over by the selenium.



These cells are claimed to have great stability, and should, with proper treatment, remain effective for many years. As no wire is used in their construction, short-circuiting is excluded. Their efficiency, measured by the useful current obtainable on illumination, is well above that of the best previous types. This claim, put into figures, is as follows:

With a sensitive selenium surface of 5 sq. cm., and a voltage of 20, the additional current obtainable at various illuminations is as follows:

1 metre-candle .....¼ milliampere
50 metre-candles .....1 milliampere
500 metre-candles .....2 milliamperes

The cells are constructed under the supervision of Dr. Fournier d'Albe, A.R.C. Sc., the inventor of the Type-reading Optophone, and are made in two standard patterns. Type A, suitable for working relays; resistance about 10,000 ohms. Type B, suitable for use as Photophone Receivers, or for other applications of intermittent light; resistance about 100,000 ohms. Type A has a sensitive surface of 5 sq. cm., and is guaranteed to yield the currents above specified. Type B has a sensitive surface of 0.3 sq. cm., and is guaranteed to detect an intermittent illumination of 25 metre-candles with a sensitive telephone receiver and a battery of 20 volts. Larger patterns are constructed by special arrangement. The size of standard cells is 2x2x1 inches overall and weight 2¼ ounces.

HANDY RESISTANCE UNITS.

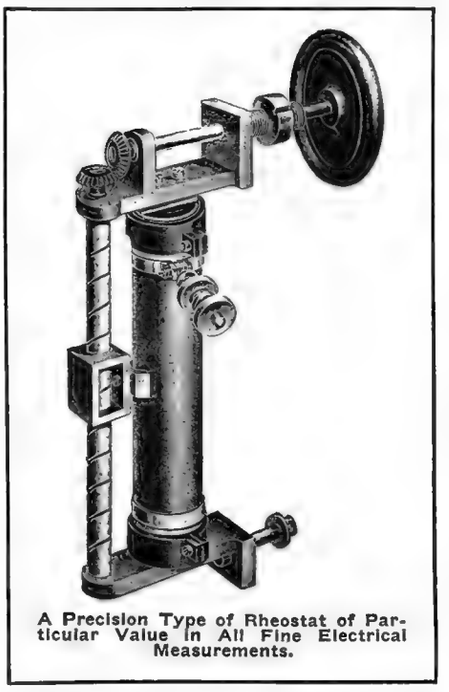
Something every electrical man wants at some time is a standard resistance unit. Each resistance unit of the type illustrated is mounted in a block of hard wood with shellac finish. The terminals of the resistance are attached to spring binding posts. The resistance unit blocks are 1¾ inches square and 2½ inches high, and can be arranged together like blocks in various combinations. The resistance wire is wound bifilar on a large diameter spool which is concealed in the block. All units are adjusted to within one-twentieth of one per cent accuracy. Each unit will safely carry a load of 2 watts which will produce a final temperature rise of 50°C.

New Form of Handy Resistance Unit. It Is Supplied in Any Size Desired.

These resistance units will be found of great convenience for obtaining any desired resistance value. (The desired value is quickly obtained by series, parallel, or series-parallel combinations of the units); for shunting a galvanometer to make it critically damped, or to reduce its sensibility; making up the ratio coils of a slide-wire bridge or a Kelvin double-bridge; multiplying the scale of a voltmeter or wattmeter by increasing its resistance; building up a "volt box" to use in connection with a potentiometer and for building up resistance combinations to teach students to calculate and measure the same.

A PRECISION TYPE OF RHEOSTAT.

It is often desirable in electrical work, especially when making delicate measurements, to have available a finely adjustable resistance such as the one illustrated. This particular rheostat is of English manufacture and comprises a metal tube covered with insulation and over which many turns of closely wound bare resistance wire are placed.



A Precision Type of Rheostat of Particular Value in All Fine Electrical Measurements.

By means of the usual hand wheel projecting at the right and the geared worm, it becomes possible to move the adjustable spring contact very accurately along the resistance coil. In order that this movement shall not require too many turns of the hand wheel, the pitch of the thread on the worm shaft is made quite long or about one-half inch. The particular precision rheostat illustrated is designed to be mounted on the rear of a switch-board panel and the regulating knob or wheel only projecting thru on the face of the panel. It should prove ideal for all kinds of electrical measuring circuits, as well as wireless circuits.

The new battleship Tennessee will use 27,500 electrical horsepower, enough power to furnish heat, light and power for a city of 100,000 inhabitants.

A VERTICAL TABLE FAN.

The advantages of the new electric table fan shown in the accompanying illustration lie in the fact that it can be used on a dining-room table or a flat top desk without disturbing the papers or articles on the desk's or table's surface. The breeze is distributed in a strata of about one foot above the table level, and has a radius of six to ten feet. Therefore, everyone seated within that radius, receives a continuous breeze instead of the intermittent and often annoying strong blast of the ordinary oscillating fan.

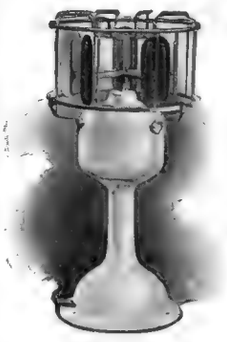


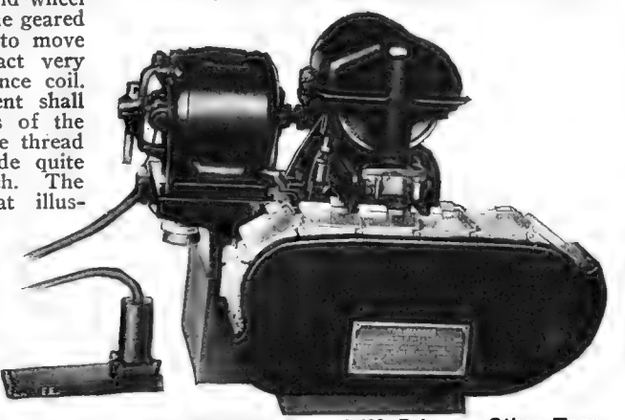
Table Fan for Use on Dining-room or Library Tables to Give All-around Breeze.

ELECTRIC TAG MARKER SAVES TIME.

The marking of price tags in dry-goods, and department stores particularly, is a slow and tedious task if done by hand. The simple motor-driven tag marker shown changes all this. By its use 2,400 tags can be printed in an hour.

The mechanism of this tag marker, which is driven by a 1/20 h.p. motor thru a worm and gear, consists of a set of cams, which move an endless chain of aluminum trays beneath a miniature type chase. The tags are printed as they move along on these trays. The trays are hand fed. A tag is placed in each tray beneath a clip which holds the tag in place from the time it is fed into the machine until marked by a downward movement of the type chase. This insures uniform register of the marking. When the tag is printed it is automatically released from the clip and discharged from the tray at the end of the machine.

The machine will accommodate any size or shape of tag up to 1¾ inches wide, of any thickness from thin paper up to cards 3/32 inch thick. The type chase is adjustable to adapt it to various sizes of type and is capable of marking as many as seven lines with fifteen small characters or nine large characters on a line. The type commonly used is of metal, full twelve point (⅙ inch high). With the usual set up of the chase, it is possible to print both the tag and the stub with the words *Lot, Size, Price* and some other word if needed.



The Electric Tag Marker Prints 2,400 Price or Other Tags an Hour.

This tag marker is compact, portable, very quiet in operation due to the worm drive, and only weighs 45 pounds.

Notice to All Radio Readers

As most of our radio readers are undoubtedly aware, the U. S. Government has decided that all Amateur Wireless Stations, whether licensed or unlicensed, or equipt for receiving or transmitting, shall be closed.

This is a very important consideration, especially to those who are readers of THE ELECTRICAL EXPERIMENTER, *for the reason that we desire to continue to publish valuable articles in the wireless art from time to time, and which may treat on both transmitting and receiving apparatus. In the first place, there are a great many students among our readers who will demand and expect a continuation of the usual class of Radio subjects, which we have publisht in the past four years, and secondly, there will be hundreds and even thousands of new radio pupils in the various naval and civilian schools thruout the country, who will be benefited by up-to-date wireless articles treating on both the transmitting as well as receiving equipment.*

Therefore, and in view of the foregoing explanation, we feel sure that every reader will thoroly understand that altho articles on transmitting, as well as receiving, apparatus may appear from time to time in these columns, he is not permitted to connect up any radio apparatus whatsoever to any form of aerial.—The Editors.

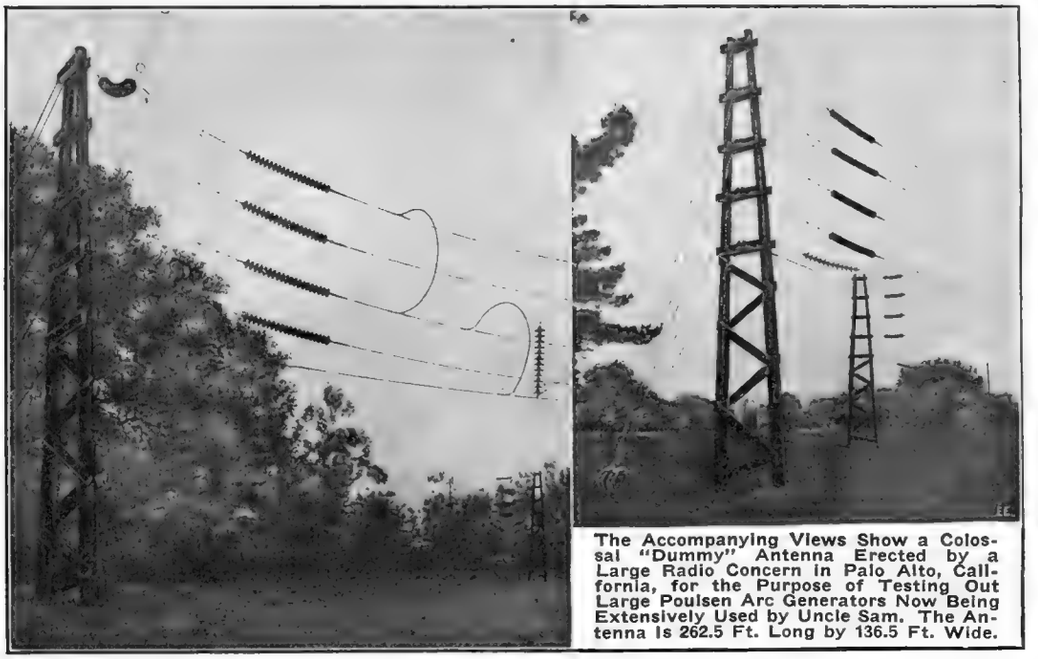
Testing Radio Units With Dummy Antenna

By FRANK C. PERKINS

THE accompanying illustrations, figures 1, 2 and 3, show the equipment used for testing radio units of the Federal Telegraph Company with a *Dummy Antenna,* as utilized at the Palo Alto, California, laboratory. It was possible, with this antenna, to reproduce practically any antenna found in commercial radio telegraph stations, and therefore observe the performance of the wireless sets under practical operating conditions.

The Arc Radio Transmitters are now produced for commercial uses in ratings from 5 to 500 kilowatts, and the 350 K.W. unit has an overload rating of 500 K.W.

It is pointed out that when electrical engineers test a dynamo they are not likely to disturb engineering operations in other buildings, or even in other parts of the same building. When, however, they test a radio plant of considerable power they are likely to disturb the *ether* for hundreds of kilometers in all directions. A need arises, therefore, for a *dummy antenna,* or a *radio load* for testing radio generators, which shall not seriously stir up and vex the ether in the vicinity. The problem is to load the generator but to suppress the output beyond a short range. This is a problem in radio inefficiency, and is just the reverse of the ordinary problem of the radio engineer, which is to load his generator as efficiently as possible, so that the effects may be manifested at a great range.



The Accompanying Views Show a Colossal "Dummy" Antenna Erected by a Large Radio Concern in Palo Alto, California, for the Purpose of Testing Out Large Poulsen Arc Generators Now Being Extensively Used by Uncle Sam. The Antenna Is 262.5 Ft. Long by 136.5 Ft. Wide.

The dummy antenna at Palo Alto consists of a series of horizontal galvanized iron wires in five layers, so arranged as to be capable of forming an air condenser of adjustably variable capacity up to about one-thirtieth of a microfarad. With such a capacity carrying 250 amperes, at 20,000 cycles per second, the voltage, neglecting all losses, would be approximately 64,000. Sixty-four kilovolts driving 250 amperes in quadrature would develop 16 megawatts of reactive power.

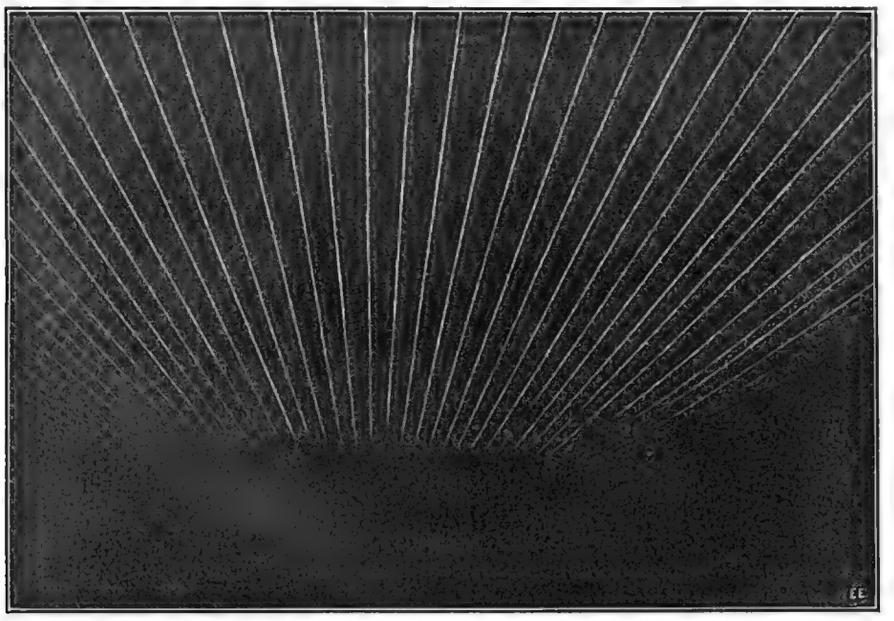
It is pointed out that an active power rating of 200 K.W. would thus only demand a little more than 1 per cent of dissipation factor. It is evident that this dummy has large dissipation possibilities. In making radio units of larger capacity than have heretofore been attempted, it was found necessary to provide a dummy antenna which could be used for testing Federal-Poulsen Arc converters of various sizes. Because of the large units contemplated, and since interference with nearby commercial stations had to be avoided, the type of construction shown in the accompanying illustrations was developed.

It may be stated that this afforded capacities up to 0.031 microfarad, and by being of such construction as to have a low effective height, caused a minimum of interference. The antenna consists of five parallel layers of wires spaced 5 ft. apart vertically. The wires in each layer are 2 ft. apart horizontally and there is a 10 ft. clearance between the ground and the lowest point in the bottom layer. The bottom layer, which is grounded, is 136.5 ft. wide, with a maximum length of 262.5 ft.

It is of interest to note that the other layers, insulated from ground, are 20 ft. shorter and 41 ft. narrower. The insulated layers have fifty-one wires each and the grounded layer sixty-six wires. The two outer wires on each side of the four top layers are size No. 2, because the edge wires are not shielded as well as the others and it was desired to prevent the *corona* which would otherwise appear at the edges of these layers. With this exception, No. 14 galvanized telephone wire was used in all layers, and the wires are fastened at each end to 1-in. stranded cables. Altho galvanized wire is not generally considered good practise in radio work, it was nevertheless used on this antenna because with the large number of wires employed the

resistance could be kept within the usual limits.

For convenience the five parallel layers of the antenna are numbered from the top down. Layers Nos. 1 to 4 inclusive are well insulated, and a long length of halyard



Wonderful Night Photograph of "Dummy" Antenna in Full Activity. Note the Corona Glow on the Wires Caused by a Charge from a 300 K.W. Federal-Poulsen Arc Generator.

between the insulation and the supporting towers was provided in order to permit of putting in more insulation with suitable corona shields in case this became necessary at a later date. Obviously, if this were done, only layers Nos. 1 and 5 could be used, because the large diameter of shields necessary with such a long string of insulators would otherwise interfere, the layers being only 5 ft. apart.

It will be observed that provision was also made for the installation of corona shields on the insulator strings now used, but no trouble of this sort has been experienced thus far and these shields have not been added. Beneath layer No. 5 are two single wires which are normally connected and have a separate lead running into the laboratory. These have a capacity of 0.002 microfarad. By various combinations of these wires with different layers of the antenna, a considerable number of capacities are available, the maximum being obtained when layers Nos. 1, 3 and 5 are connected as the earth side of the system and Nos. 2 and 4 are connected with the two single wires as the high potential side. With this combination the capacity is 0.031 microfarad.

The jumpers used for connecting the various layers consist of 1½ in. copper tube provided with suitable clamps and fittings so that shifting to different capacities is an easy matter. The capacities most commonly used are 0.006, 0.012, 0.017 and 0.024 microfarad. Many others are available. Before deciding upon the exact lengths of the antenna wires, it was noted that with evenly spaced equal loading the 1-in. cables to which the wires are attached would assume a parabolic curve. The lengths of the wires in each layer were calculated accordingly, and thus a uniform tension is secured in the individual wires of each layer without excessive pull on the pole supports.

Previous to the tests, it was desirable to tabulate the length of each wire, which was calculated to the nearest 0.01 ft. A convenient scheme was then devised for cutting the large number of wires to exact length so as to secure the parabolic curve in the 1-in. cables. Two short posts, exactly 200 ft. apart, were set up on the site with several intermediate stakes between. The wire was unwound from the reel near one of the posts and run out with a "come along" grip to the desired length beyond the second post.

There was steel tape with its zero on the second post stretched out beyond it with the wire and the end of the wire was placed at the exact tape reading before signaling. Having the end of the wire held firmly in place on the tape, a man near the reel put steady tension in the wire by means of a "come along" grip until the wire was just raised above the intermediate stakes, and then, upon signal from the man at the tape, the wire was cut with pliers at the first stake. After cutting each individual wire the crew, consisting of two men at each end, proceeded at once to fasten it in place on the 1-in. cable which had been previously stretched, to remove twists, and laid out on the ground in position for hoisting. In cutting the wires, 1 ft. over and above finished dimensions was allowed for connections.

There was then a point 6 in. from each end measured off with a rule, and this point was kept at the inner side of the cable while the end of the wire was given two turns around the cable and sufficient wrapping to secure it. The antenna as a whole reaches the corona point with an undamped high-frequency current of 250 amperes at a frequency of 20,000 cycles. The accompanying night photograph, Fig. 3, shows a layer of the antenna at the corona point during the test of a 300 K.W. Federal-Poulsen Arc generator. The dummy antenna was used at the laboratory for testing the high power apparatus which the company has constructed for the United States Navy at San Diego, Pearl Harbor and Cavite.

RADIO IN PERU AND SPAIN.

Measures have been adopted by the Peruvian Government authorizing the construction of a telegraph line between the cities of Ica and Castrovirreyna at a cost of 6,300 Peruvian pounds ($30,659), and the installation of wireless stations at various points in the basin of the Amazon at a cost of 10,000 Peruvian pounds ($48,665). *El Peruana* also notes that a new telegraphic code has been compiled by the Department of Telegraphs and Mails, and a commission of Government officials has been appointed to examine the code and to make a recommendation as to its adoption.

The new postal building at Madrid, Spain, is to be fitted with wireless telegraph and telephone apparatus of the latest pattern. The transmitter will be of the same type as that which made possible the transmission of the human voice from New York to Honolulu and Paris. From the central tower, 90 metres high, wire will be stretched to the three other posts, of which two are on the front and the other on the back of the building. The receiving apparatus will comprise a certain type of telephonic relay allowing the intensity of the feeble current received to be amplified 500 times.

WOMEN RADIO OPERATORS TO THE FRONT.

The National League for Women's Service has enlisted its first wireless operator. She is Miss Helen Campbell and she is an expert in receiving and sending. She entered the service of the League on May 8th. Women in all parts of the country are taking up the study of telegraph and radio operating in earnest, as these vocations hold undeniable promise for those aspiring to fill positions of responsibility and service to the Nation. Besides, there will be plenty of opportunities after the war for radio and telegraph experts.

Photo by Bain News Service

Miss Helen Campbell Has Successfully Mastered the Intricacies of Radio-Telegraphy. She Is an Expert in Sending and Receiving Radio Messages.

HOW THE GOVERNMENT SEALS RADIO APPARATUS.

Uncle Sam's radio inspectors have been extremely busy the past few weeks sealing up all radio apparatus not in actual use by the Government.

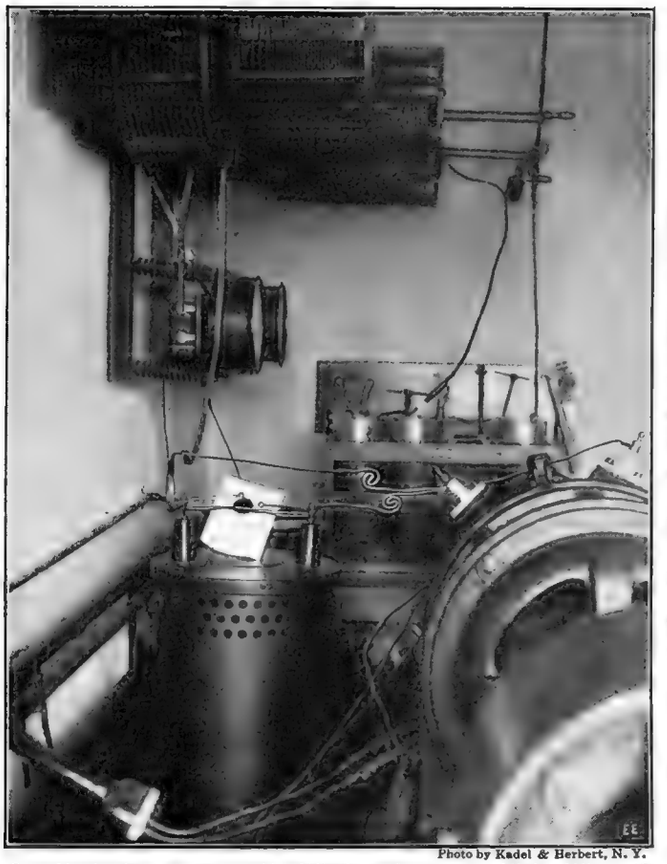


Photo by Kadel & Herbert, N. Y.

Our Uncle Samuel Seals Up Wireless Apparatus Tight When He Does the Job. A Heavy Wire Is Run Thru All the Binding Posts and Sealed as Shown, and Woe Be Unto Anyone Who Maliciously Breaks the Seal.

Heavy wire is wrapt around the poles of the spark gap and the ends of this wire are joined with wax bearing the great seal of the United States of America. Heavy prison penalties are provided for the breakage of this seal. The wire short-circuits the spark gap and makes it impossible to secure a spark. The impression of the great seal is made in red wax on an ordinary piece of paper.

U. S. CALLS FOR TELEGRAPH AND RADIO OPERATORS.

The war's demand for telegraphic communication has increased so much that an emergency call has been issued thru the War Department for young men and women of the country to present themselves to be trained as telegraph operators. Arrangements have been made with the Western Union Telegraph Company to train 2,500 new operators. These are to enable the Government to handle its war telegraph business without taking any more operators for the Signal Corps from the present railroad and commercial telegraph forces, and without seriously interfering with vital communications.

The War Department's appeal follows:—

"Several thousand young men and women are needed for telegraph service, either in the Signal Corps of the army, or to replace those in commercial work who are leaving positions to join the colors. These young people must be trained. For this purpose the Western Union Telegraph Company has placed its facilities at the disposal of the Government to train twenty-five hundred operators, and the training will be conducted by its experts.

"It is estimated that there are more than 30,000 amateur wireless (sending) operators in the United States. These young men now have an opportunity—perhaps the only opportunity of their lives—to contribute materially to their country's welfare in an hour of need by volunteering for this work. At the same time they will be mastering a trade in which stable employment can almost always be secured in any important city.

"Telegraph operators in the army and navy occupy preferred positions both as to rank and pay. Young men who take up telegraphy, but who do not enter the Government employ will still render patriotic service by relieving those who desire to enlist.

"The tremendous demands upon the operating forces of the country during this period of intense activity—the mobilizing of all the resources and energies of the American people—have taxed the present telegraph forces to the utmost and necessitate the immediate recruiting of hundreds of volunteers for this service. The Government needs telegraph operators for its Signal Corps.

"Amateur wireless operators, women typists, and all other competent young men and women possessing the fundamentals of grammar and high school education and not already employed in service contributing to the national welfare, are urged to apply to the offices of the Western Union Telegraph Company to take up telegraphy training. By so doing they will serve their country in a very practical and patriotic way."

A HUMAN RADIO OUTFIT!

Radio Fiends and Bugs—Please Take Notice of the Master Incarnated Wireless Vampire. This Photo, Which Came to Us Anonymous—by Wireless of Course—Shows How the Fiend Is Gradually Turning Into a Radio Outfit. His Legs Already Are Long Switch Levers, and Before We Go to Press, His Brain Probably Will Have Turned Into an Ether Wave! Here at Last We Have a Radio Enthusiast Who Loves His Set Well Enough to Get Married to It!

MANUFACTURING WIRELESS APPARATUS FOR SUBMARINE CHASERS.

Radio manufacturers are now working night and day building apparatus for the U. S. Naval vessels. The photo shows quenched spark gaps being machined.

These spark gaps are brass discs with silver centers, and they must be accurate to 1/10,000 of an inch. Measurement is made by the small dial above the pin which shows the accuracy. If the spark gaps are inaccurate they must be sent back to be machined to the proper dimensions. Sixteen of these discs are installed in each set for submarine chasing purposes.

A new radio station has recently been erected at Viacha, near La Paz, Bolivia. Commercial service was established on Oct. 20th.

Photo by Kadel & Herbert, N. Y.

Manufacturing Quenched Spark Gaps In New York City for U. S. Naval Vessels. The Gap Plates Must Be Machined to 1/10,000 Inch Accuracy.

CORRECTION NOTICE!

In the article appearing in the May issue and entitled "Receiving the Marconi 300 K.W. Stations on the Oscillating Audion," by S. Curtis, Jr., an error was made in stating that Dr. White of the General Electric Company's research staff had succeeded in getting an Audion type of oscillator to operate at wave lengths as low as ½ meter. This should have read 6 meters, which wave length of oscillation was only obtained with a perfect non-gaseous bulb.

How Radio Brought the News to the Farm

WEATHER reports, market quotations and world news daily by wireless telegraph, such is the innovation which makes the farm and the work of Archie Banks, of Delmar, Iowa, of more than ordinary interest. The last vestige of isolation and aloofness from the world has been banished from the farm by this young Iowan. Back of his achievements lies a story of determination which should be an inspiration to all.

Eight years ago Archie Banks was a sixteen-year-old boy, living on the farm of his father, a well-known live stock farmer. The boy had always been interested in machinery and mechanical matters, but met with little encouragement along this line from his parents. He might never have had an opportunity to develop his latent talents had it not been for an accident. One day, in working about her household task, the boy's mother knocked off the telephone batteries.

"Central told her how to connect them up again and she did so," says Mr. Banks. "I happened to come in then and she told me what she had done. Of course, I wanted to see if she did it right. I was promptly told to run along and that what I knew about telephone batteries wouldn't bother anyone. Well, I made up my mind I would know something about them, and I set to work studying everything I could get hold of—books, magazines and catalogs. In a year I had the house wired from cellar to garret, and lighted with electric lights run from batteries. Two years afterward I had a small wireless built, but it would not work well. All I could do was to talk to Delmar, a mile away. I determined to do better, and so I set to work again."

This second time the boy was more successful, so that today he has installed in the twelve-room farmhouse, a mile from Delmar and about eight miles from Maquoketa, a complete wireless telegraph outfit, by which he receives weather forecasts and news bulletins twice a day from the wireless stations connected with the Illinois State Agricultural College, at Springfield, and the Iowa State Agricultural College, at Ames. (Prior to the war of course). Weather reports are sent out by these stations every day at noon, while news bulletins and the events of the world are sent twice a day—at noon and again at 8:30 in the evening.

But Mr. Banks did not stop with this. He did not believe in being selfish. He had this news service himself; why not share it with friends, neighbors and passers-by? Accordingly, the weather forecasts and the news bulletin were telephoned from his farmhouse to whoever desired to receive them, the climatic changes being known for a radius of ten or fifteen miles, long in advance, by means of this excellent service. Farmers who live near Mr. Banks did not have to wait for the belated newspaper which the R. F. D. carrier delivered to see what the weather would likely be the next few hours; they were not caught unprepared by any sudden and unpredicted change in temperature; a minute at the rural telephone, to secure proper connections with the Banks farmhouse, and the weather forecast was known by them as promptly as it was known by the man in the city, with the daily paper laid on his desk but a few minutes after it had left the press.

This is not all, however. As one drives toward or from Delmar, along the road which leads by the Banks home, he comes suddenly upon a large sign stretched across the road, a board sign eight feet long and two feet high, upon which is painted, in large words, this placard: "Eat honey, For sale here. Today's weather report by wireless on next curve. Archie Banks." A few rods further on, at the first turn in the road stands the large bulletin board, eight feet high by five feet broad. Upon it Mr. Banks used to post the weather forecasts and the news bulletin, each day, just as soon as they were received. Whoever drove by the Banks' home got the news of the world as promptly and as accurately as the city man got it from reading the bulletin board of the metropolitan newspaper office.

All this is not without its business effect. Mr. Banks (now twenty-four years of age and farming for himself) owns and operates a farm of 160 acres, carrying on a general farming business. He has two particular hobbies, however—electricity and bees. Prior to December 10, he had sold almost 3,000 pounds of honey last year; he could sell much more if he had it, for his honey is of good, uniform quality, and Delmar is in the midst of a rich honey section, many carloads being shipt from there to all points east and west. Passers-by who would stop at the Banks' home to read the bulletin board, or to inspect the wireless plant, bought honey and thus came to be regular customers of the apiary, adding to a side-line income, which has already begun to assume large proportions. There was no thought of the business possibilities of his wireless service when it was first inaugurated, but there is a close connection between the two, without a shade of doubt.

Nor must it be thought that Archie Banks is not a genuine farmer; he is in love today with farm life and with the beautiful farm which he bought of his father, with the big twelve-room house set in its grove of maples and elms 100 feet back from the road, with one room given over to the wireless outfit, which brings that particular farm into touch with all the outside world.

"The wireless station is about as complete as I can make it," says Mr. Banks. "I have copied messages from Darien, Panama; Hanover, Germany; Mare Island, and San Diego, California; Guantanamo Bay, Cuba; Arlington, Virginia; New York City, and all over the world. I received New York messages so loud that the signals could be heard all over my house, which is of twelve rooms."

Now That the Country Is in a State of War and All Amateur Radio Stations Are Closed, Mr. Archie Banks, Owner of the Elaborate Wireless Station Here Pictured, Has Offered His Station and Services to Uncle Sam. Before the War He Used to Receive the Daily Weather Reports and Other News, Which Was Posted on a Bulletin Board in His Home Town—Delmar, Iowa.

Wireless on the American Submarine Chasers

By SAMUEL COHEN

THE greatest task of the United States in the war against Germany is that in overcoming the under-sea monsters, the SUBMARINES, which have proven to be a constant and rapidly increasing menace to both the Allied and American shipping.

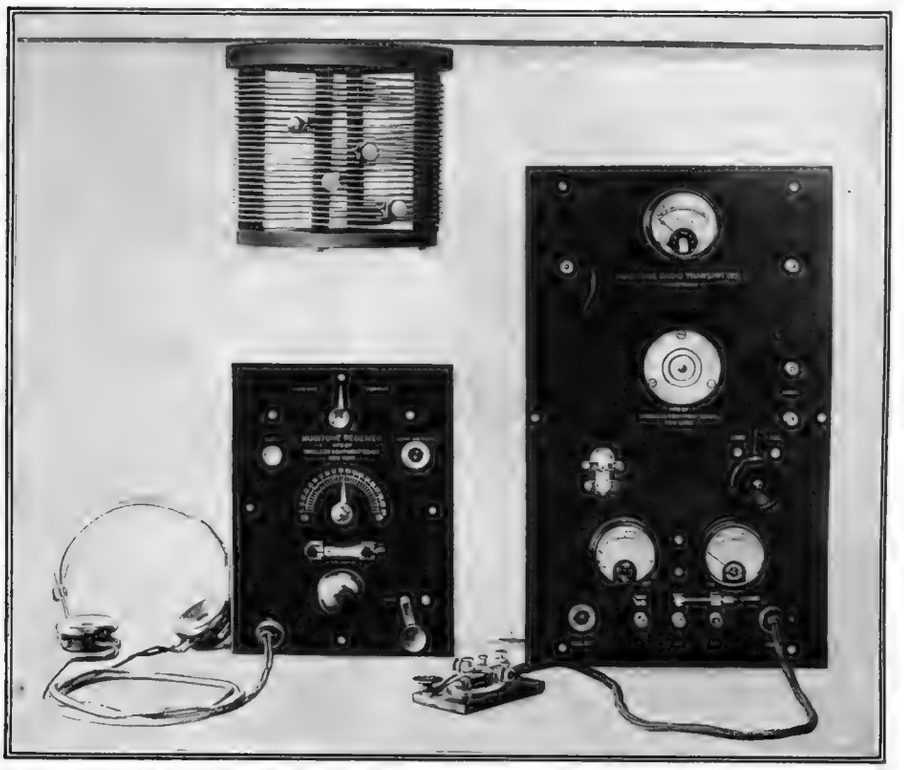


Fig. 1—Space Is at a Premium on the "Submarine Chaser." For Such Radio Service There Is Available the Extremely Light-Weight Transmitting and Receiving Set Illustrated. It Utilizes a Spark Coil with Independent Vibrator for Batteries.

This problem is now in the hands of our most prominent scientists, inventors and marine experts, and one solution to this task seems to have been found in the building of hundreds or even thousands of high-speed armed motor-boats to be used in fighting the U-boats.

One of the most important details in equipping these "submarine chasers" is that of radio-communication apparatus to be used for notifying near-by vessels of submarine attacks and the like. The marked development in the art of radio-telegraphy in recent years has demonstrated that every vessel to be used for the above named work should and can be equipt with a suitable light-weight, yet highly efficient radio transmitting and receiving outfit.

A considerable variety of such apparatus have already been designed and built and we give below descriptions of several types of transmitting and receiving sets which will prove very effective for the work in question. The accommodations offered by submarine chasers are few and for this reason the radio engineer must comply with the accommodations as much as possible before he undertakes the designing of the equipment. Space is a very important factor in consideration, and for this reason the apparatus herewith described have been chosen since they are of the most compact type ever built for the efficiency which they have shown.

The first of these outfits is illustrated at Fig. 1. This set was designed and built by Mr. A. B. Cole, of New York City. The transmitting set is seen on the right and the apparatus comprising the installation consists of the following and all of which are mounted on a Bakelite panel. The source of high tension current for charging the condenser is derived from a special spark coil, stationed behind the panel. An independent vibrator is employed and this is mounted on the panel, and may be seen directly to the left of the antenna switch, which is the right circular knob. A number of important features are incorporated in this independent vibrator, *viz.*, a high-tone, corresponding to a 500 cycle generator, is obtained with a primary excitation of 6 volts, obtained from a storage battery. The current consumed by the primary of the spark coil is indicated by the two lower meters; the one toward the left indicates amperes, and the one toward the right, volts. The simple-pole double-throw switch below the two meters is used to throw in either 6 or 12 volts onto the primary of the coil; the latter voltage must naturally be derived from a 12 volt battery or other generating source. Terminals for the current source are located below the switch. The plug towards the right interconnects a key with the coil as perceived; while the plug on the left is employed for connecting the receiving apparatus with the antenna and ground, thru the change-over switch which is located directly over the voltmeter.

The oscillatory circuit of the equipment consists of the secondary of the induction coil generating the high tension voltage which is used to charge a moulded type condenser, thru an inductance and a quenched gap discharger, the latter being visible in the center. Annular grooves are cut on the surface of the outside plate for rendering greater cooling facilities to the gap. A *radiation ammeter* is also furnished and this is placed on top of the panel.

The receiving equipment consists of a standard cabinet outfit, with crystal detector which can be seen to the left of the transmitting panel. It is comprised of an inductively coupled tuner which has a fixt coupling coil, linked with a variable capacity for tuning to different wave lengths. This condenser is mounted in the center. A *short* and *long* wave change-over switch is employed and this is placed at the center upper corner. The detector is of the mineral type and is mounted below the condenser, while the buzzer, for test work is just below the detector.

The complete outfit has been found to be very satisfactory and efficient and it will no doubt prove to be highly serviceable to Uncle Sam's mosquito fleet.

In addition to the excellent transmitter above described a very efficient and an all-around receiving outfit has been designed and built by Messrs. L. G. Pacent and A. H. Grebe for the submarine chasers, and this outfit is illustrated in Fig. 2. This equipment consists of four units, *viz.*, a main tuning cabinet, loading cabinet, detector

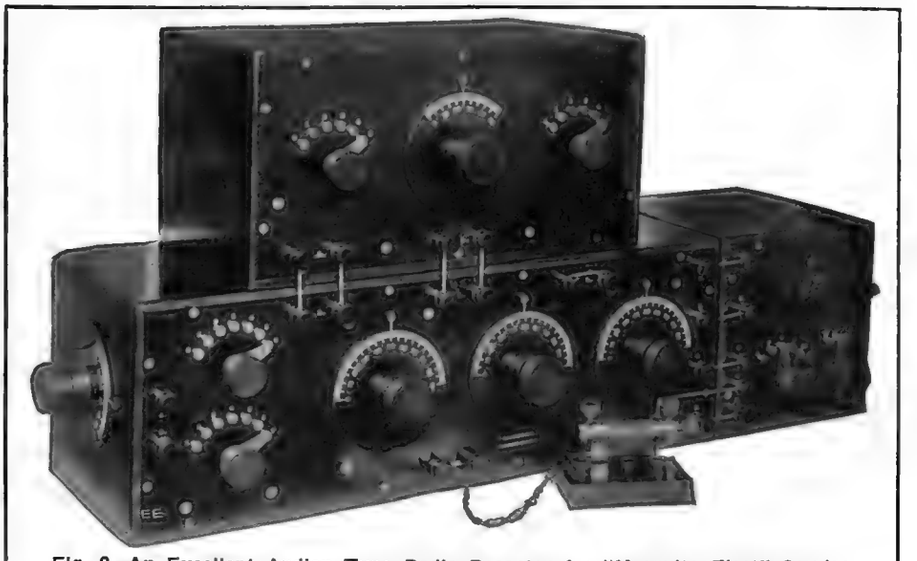


Fig. 2—An Excellent Audion Type Radio Receptor for "Mosquito Fleet" Service. It Is Fitted with "Radiumized" Dials That Glow in the Dark.

cabinet, and an emergency crystal detector. The main tuning cabinet is the largest of the three and comprises an inductive coupler, coupled with variometers, the latter of which are controlled by two handles, while the center one operates a variable condenser linked in the secondary circuit. The handle on the left side is used to control the secondary coupling. The two-point switches are employed for regulating the inductance of the primary of the inductive coupler.

The cabinet on top of this is the loading box which contains the proper coils for aiding the regenerative Audion circuit; the center knob is the coupling handle, while the two side knobs are the inductance control handles. The cabinet to the right is the detector box in which the vacuum detector is housed. An opening fitted with a sliding door is used to note the illumination brilliancy of the detector bulb. The switch to the right is the *filament* switch while the one to the left is the "B" battery control switch. A variable resistance is secured to the side of this cabinet (not shown here) and this is used for regulating the current consumption of the filament. The emergency crystal detector is hooked up to the set thru binding posts at the bottom of the main tuning cabinet.

One of the most striking characteristics of this receiving outfit is that which has been overlooked by all of our radio engineers designing apparatus intended for warfare purposes. This is the application of the wonderful properties possest by radium of giving forth light when mixed with certain phosphorescent materials. All of the graduated dials of this equipment are painted with phosphorescent radium paint which glows in the dark, and which facilitates working operations of the operator when he is ordered to have his den *pitch dark* during certain engagements in war. This will certainly be appreciated by the radio operator who has to operate this receiving set. All connections of the various pieces of apparatus are made by means of square shaped aluminum wire which has been found to be very effective for wiring purposes, as it is easier to wire and at the same time gives a better appearance to the finished instrument. It also reduces the weight.

The illustration, Fig. 3, shows a well-built set designed by Cutting and Washington. This outfit utilizes a new principle in radio transmitter design involving the use of a special spark gap, by means of which powerful oscillations and a hy-note signal are produced in a very simple manner without a transformer. The antenna wave length can be changed with this set by altering the secondary of the oscillation transformer only, the primary remaining fixt.

Fig. 3—Particularly Efficient Radio Set Well Adapted to "Mosquito Fleet" Service.

A Medal of Honor to be Awarded by the Institute of Radio Engineers

The Board of Direction of the Institute of Radio Engineers has decided to award annually a "Medal of Honor" to such persons who have distinguished themselves by unusual advances in the fields of radio-telegraphy and telephony. It has been felt that some way should be found whereby valuable work in these fields of great and rapidly growing importance might properly be recognized by an authoritative engineering society. As is well known, the Institute of Radio Engineers, with more than 1,000 members here and abroad, and with sections in New York, Washington, Boston, Seattle, San Francisco (with others in contemplation), is the leading technical and scientific society in the wireless field. It is therefore recognized that a "Medal of Honor" from the Institute will be a goal worthy of attainment by any investigator.

New "Medal of Honor" to be Presented by the Institute of Radio Engineers Each Year to the Person Who, During the Two Preceding Calendar Years, Shall Have Made Public the Greatest Advance in the Art of Radio-Communication.

The appearance of the medal is as follows: The front is a symbolic representation of electromagnetic waves, indicating the interlinking of the magnetic and electric forces in their rapid path thru the depths of space. The reverse side bears the inscription:

"To ....., in Recognition of Distinguished Service in Radio Communication" (followed by the date), the inscription being surrounded by a laurel wreath.

The medal is the work of the well-known sculptor, Edward Sanford, Jr., of New York.

The award will be made yearly at the April meeting of the Institute to the person who, during the two preceding calendar years, shall have made public the greatest advance in the art of radio-communication. The advance may be a patented or unpatented invention, but it must be completely and adequately described in a scientific or engineering publication of recognized standing and must be in actual, tho not necessarily commercial, operation. However, preference is to be given to widely used and widely useful inventions.

The advance may also consist in a scientific analysis or explanation of hitherto unexplained phenomena of distinct importance to the radio art, altho the application may not be immediate. Preference will be given to analyses directly applicable in the art. In this case also publication must be full and in approved form.

The advance, furthermore, may consist in a new system of traffic regulation or control, a new system of administration of radio companies or the radio service of steamship, railroad or other companies, a legislative programme beneficial to the radio art, or any portion of the operating or regulating features of wireless. It must be described publicly in clear and approved form and must, in general, be actually adopted in practise. In all cases, marked preference is to be given to advances made in the preceding year.

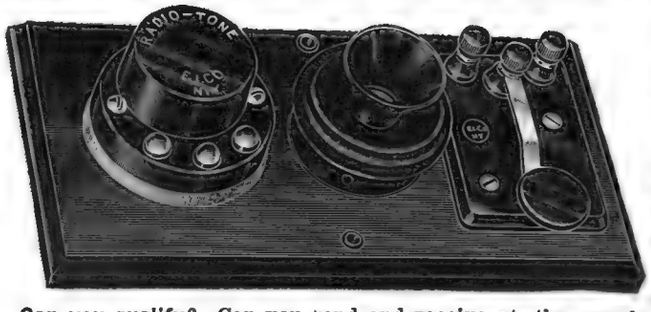
The medal is to be awarded under the following conditions:

At least thirty days before the April meeting the Board of Direction will call from a number of members and fellows of the Institute, whom it may choose to consult, for suggested candidates. This provision will be waived wholly or in part for 1917 only.

In deciding upon the award, the Board at its April meeting, thru those actually present or voting by mail, will nominate at least one, but not more than three candidates, in order of preference for the award. The names of these candidates will then be sent to each member of the board, who will have the privilege of returning a vote for one candidate. Four weeks after the April meeting the ballot will be read, and the candidate receiving the most votes will become the recipient of the award.

The official presentation of the medal to the successful candidate or his representative will occur at the May or June meeting.

"ELECTRO"



AMATEURS! ATTENTION!!

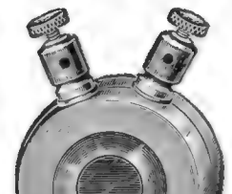
Now that we are for the time being, deprived of using our Radio outfits, it behooves us to become proficient in learning the Wireless Codes. Operators who know the Code are, and will be, in ever rising demand. The army and navy need thousands of operators right now. **Can you qualify?** Can you send and receive at the required speed, when your country calls you?

The **Radiotone Codegraph** is positively the only instrument made that will send such an unbelievably close imitation of a high pitch Radio Station, that it has baffled experts. The outfit replaces the old-fashioned learner's outfit, consisting of key and sounder. The **Radiotone Codegraph** comprises our famous Radiotone High Frequency Silent Buzzer, a special loud talking receiver with horn, and a key all mounted on a base. Operated on one or two dry cells, the phone will emit the characteristic high pitch sound, which while not harsh, is heard all over the room. With little trouble you can learn the code correctly in 30 days—

AND THAT IS NOT ALL:

Connect two of these outfits together for intercommunication work and you and your friend five or fifteen blocks distant can converse over a NO. 36 WIRE, so fine that no one will see it. Or you can use instead of the wire, a metallic fence and the ground. **Or you can communicate over your 110 lighting line,** using no extra wire, only the ground. Full directions how to do this are furnished with the instrument. **DEALERS:** This is the 20th Century instrument that will sell like WILDFIRE., 600 sold in New York in 10 days. Get our proposition today!

Radiotone Codegraph complete as described, each, **$1.95**
IMMEDIATE SHIPMENTS



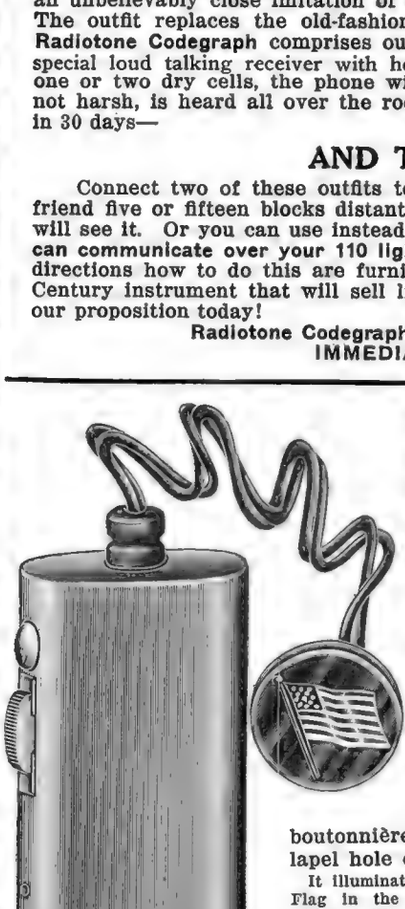
No. FX517

Selenium Cells

Everybody has read about the experiments of telephotography (sending photographs over a wire hundreds of miles) made by Professor Korn and others. It is also known that if the problem of tele-vision is ever solved, the selenium cell will play an important role. At present we are the only concern in the United States selling these cells. They are the most sensitive ones made.

Better send for a cell today and try making an electric dog that will follow a lamp, or an electric burglar alarm. It's very instructive and great fun. (See November, 1916, issue **"Electrical Experimenter."**)

No. FX517 Selenium Cell, each $6.00
Shipping Wght., 4 oz.
IMMEDIATE SHIPMENTS



BOYS!

Here Are the Stars and Stripes in All Their Glory.

Be the first one in your town to wear this patriotic emblem. Think of it: An electrically illuminated boutonnière worn in the lapel hole of your coat.

It illuminates our National Flag in the original colors with a brilliant electric light. Just insert Flag in button-hole of your coat, put flash-light case in vest or coat pocket and every time you press the button, the flag in your button-hole flashes up with a beautiful color effect.

Illuminated flag, cord and plug (to be connected to any 2 cell flashlight), **$.60** (postage 10 cents).

Illuminated flag, flashlight case and battery, cord and plug, complete as per illustration, $1.10 postage 15c).

DEALERS: Write for our proposition today.
IMMEDIATE SHIPMENTS

THE "ELECTRO TELEGRAPH"

$1.00

is not a toy, but a practical, honestly built telegraph outfit, which not only sounds but works like the big commercial instruments. By studying the code for 30 days you can become a first-class telegraph operator. Such operators are in big demand now. Outfit consists of TWO complete telegraph instruments each measuring 3½x2½x2¼. All metal parts are highly nickel plated, including key lever. Note hard rubber knob. Telegraph Code Chart, telegraph blanks and connecting wire comes with set, but no batteries. Outfit works on 2 dry cells (one cell for each instrument). The "Electro" is the ONLY Outfit that works both ways, each station can call; no switches, no extras. Nothing to get out of order. Guaranteed to please you or money back.

Price Complete as illustrated..... $1.00

At all good dealers and department stores. If your dealer cannot supply you send us $1.00 for outfit and add mailing charges for two pounds, otherwise we ship express collect.

THE ELECTRO IMPORTING CO.

Pat
No.8
Feb5
No.9
Oct2
No.9
Feb1
No.9
Mar.
No.96
June2
No.9
Dec2
No 98
April
No 98
April
No 1,01
Jan 3
No 1,0
July 2
No 1,0
April
No 1,12
Jan 12
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NEWS

No. HK 1800

The "Electro" Radiotone

HIGH FREQUENCY SILENT TEST BUZZER

The RADIOTONE is NOT a mere test buzzer, it is infinitely more. Mr. H. Gernsback who designed this instrument labored incessantly to produce an instrument which would imitate the sound of a high power Wireless station as heard in a set of phones. This actually has been achieved in the RADIOTONE. This instrument gives a wonderful high pitched MUSICAL NOTE in the receivers, impossible to obtain with the ordinary test buzzer. The RADIOTONE is built along entirely new lines; it is NOT an ordinary buzzer, reconstructed in some manner. The RADIOTONE has a single fine steel reed vibrating at a remarkably high speed, adjusted to its most efficient frequency at the factory. Hard silver contacts are used to make the instrument last practically forever.

Yes, the RADIOTONE is **SILENT.** In fact, it is so silent that you must place your ear on top of it to hear its beautiful musical note.

You will be astounded at the wonderfully clear, 500 cycle note, sounding sharply in your receivers, when operated on one dry cell. **To learn the codes, there is absolutely nothing like it.** With the radiotone, a key and one dry cell and ANY telephone, a fine learner's set is had. Two or more such sets in series will afford no end of pleasure for intercommunication work. Particularly now that we cannot use our Wireless sets, the **Radiotone** is already in wonderful demand. All the interesting things as described with our **Radiotone Codegraph,** elsewhere on this page, can be performed with the **Radiotone,** a key, a dry cell and a phone.

Radiotone as described.....each **$.90**

IMMEDIATE SHIPMENTS

HERCULES DYNAMO

The Electro Hercules is a dynamo generating 12 Volts, 9 Amperes (100 Watts) and a marvel of electrical or mechanical efficiency and simplicity.

It is especially designed for lighting and charging storage batteries; will run 18 twelve volt lamps simultaneously. Can also be used as a powerful motor developing nearly ⅛ H.P. Machine is shunt wound; size 7 in. high, by 11⅜ in. long and 6½ in. wide. It is the cheapest Dynamo for its output on the market.

No. AGEK 1209. Electric Hercules Dynamo; shipping weight, 40 lbs. Price....**$17.50**

We carry these machines always in stock and can make immediate shipment.

The "Electro" Rheostat-Regulator

(Porcelain Base)

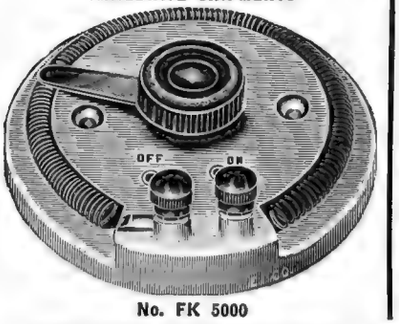
This illustration represents our little current regulator which is used everywhere to regulate battery current. It will prevent the burning out of your battery lamps, or will regulate the speed of your small motors, and scores of other uses.

It makes an excellent automobile lamp dimmer, where it can be used to cut down the glare of the headlights. This little instrument is impossible to get out of order. It is constructed **ENTIRELY OF PORCELAIN,** metal and hard rubber.

The resistance of our Rheostat is 10 ohms, the capacity 3 amperes continually, size is 4 inches in diameter; thickness of **porcelain** base is 13/16 ins.

No. FK5000 Rheostat Regulator. Price **$.60**
Shipping weight, 2 lbs.

IMMEDIATE SHIPMENTS



No. FK 5000

"Electro" Pony Receiver

No. EK 1024

Our Pony receiver is without doubt the best article for the money to-day.

Points of superiority: Hard rubber composition shell beautifully polished. Powerful permanent steel magnet, soft iron core, fibre coil heads, very thin diaphragm, brass posts inside. Hanger can be unscrewed and receiver will then fit our No. AX8077 headbands.

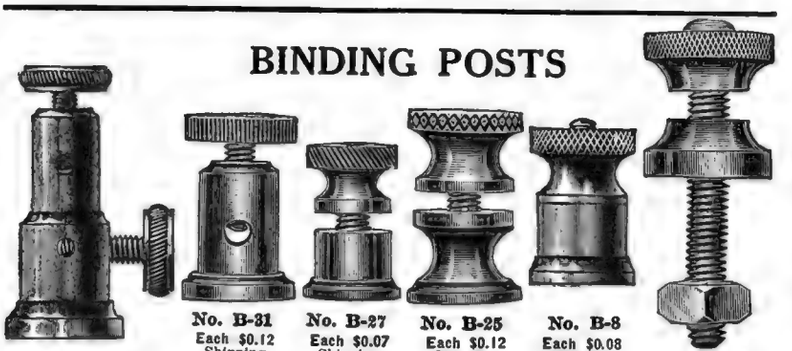
SOME USES.—For all telephone work. Also for making the small testing outfits for repair men in circuit with only one dry cell or flashlight battery. When connected in parallel with your house telephone receiver, you have a double receiver, an invaluable acquisition to those who phone in noisy places or to people hard of hearing. It can also be used for wireless though its low resistance won't permit of such good results as a higher resistance phone.

This receiver is single pole; 2¼x1⅛ inches; wgt. 4 oz.; resistance, 75 ohms. IF TWO OF THESE RECEIVERS ARE USED, IT IS POSSIBLE TO SPEAK AT A DISTANCE OF 150 FEET WITHOUT USING BATTERIES, ONE WIRE BEING SUFFICIENT IF GROUND IS USED.

No. EK1024 Pony Receiver, 75 ohms.... **$0.50**

IMMEDIATE SHIPMENTS

BINDING POSTS



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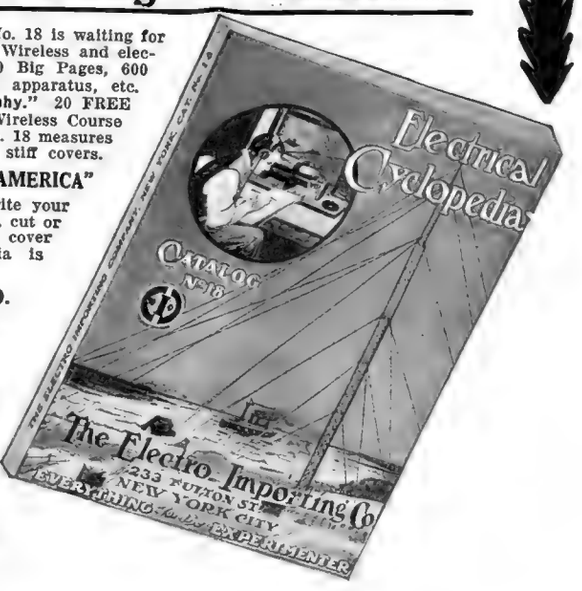


231 FULTON ST., NEW YORK, N.Y.

THE CONSTRUCTOR

An Improved Burglar Alarm Utilizing the "Stick Relay."

By ALBERT H. BEILER

MANY electrical experimenters have at one time or another installed a burglar alarm in their homes. Most of the burglar alarms constructed by amateurs are of the *open-circuit* type, and have therefore several disadvantages, the most important of these being, that, whereas the opening of a door or window causes the alarm to ring, the closing of the door or window will *stop* the alarm again. To keep up a steady ringing requires a different type of circuit than that usually employed. This may be of either the *closed* or *open* type. In the former, the current flows continuously and the opening of the circuit causes a relay to release its armature which touches the rear contact thereby ringing the alarm. The latter type is seen in the continuous ringing bell, with which most of us are no doubt familiar. There is another open-circuit device, however, which is less known, called a *stick relay* arrangement. It is this last one which we shall consider in detail.

The *stick relay* is used extensively in the interlocking machines for railway signaling. Its mode of operation insures the following result:—a circuit may be closed at a switch but not opened again at the same point; it may be opened at a second switch but not closed at this latter point. To illustrate this a little more clearly, let us refer to Fig. 1.

When the main switch M is closed, but the open circuit door or window switch O kept open, no current can travel thru the relay, and its armature will be drawn away from contact C by a retractile spring. If switch O is now closed, either by opening the door or the window, electro-magnet R will draw its armature towards it. A then touches C, and the current has two paths to travel, *i.e.*, one by way of the open-circuit door switch, and the other by branching off at B, going thru contact C and the armature, thru the magnet and back to the positive main. Should O now be opened, it will have no effect on electro-magnet R, since R still has a path by which it obtains its source of current. The current can only be shut off by main switch M, but it will be noticed that once M is opened, its subsequent closing *will not energize* the relay again, unless O is closed.

Fig. 2 shows how this principle is used in the burglar alarm. The relay instead of having only one front contact has two, one for keeping its own circuit closed as just described, and the other to close a circuit for ringing an alarm bell. The relay, which by the way, is only wound to 4 ohms, operates on 110 volts in series with a lamp or lamps, which are connected in parallel with one another. Thus when the alarm starts, not only will the bell ring, but the lamps will light and assist friend burglar towards a hasty departure. The relay may be made to operate from batteries if the builder desires to dispense with the lamps; indeed the same source of current that rings the bell may be used to operate the relay.

Since double contact relays are rather expensive, a good substitute that will cost very little, will now be described. Secure a telegraph sounder (or the equivalent parts from a large electric bell; also the parts may be easily made), one wound for 4 ohms is best if the lamps are to be used, also a piece of 5/16" square brass, 2½" long, and two pieces of ⅜" brass rod 1" long. The two pieces of rod should each have a hole drilled and tapt about half-way thru them longitudinally. The 5/16" square brass should have holes drilled and tapt as indicated in Fig. 3. Now temporarily remove the entire armature from the telegraph sounder and file the end down halfway. (Fig. 3.) Drill and tap a hole as indicated. Screw the piece B, on to it so as to form a half lap joint. Insert adjusting screws with lock-nuts into the end holes of B, and then replace the armature in its frame.

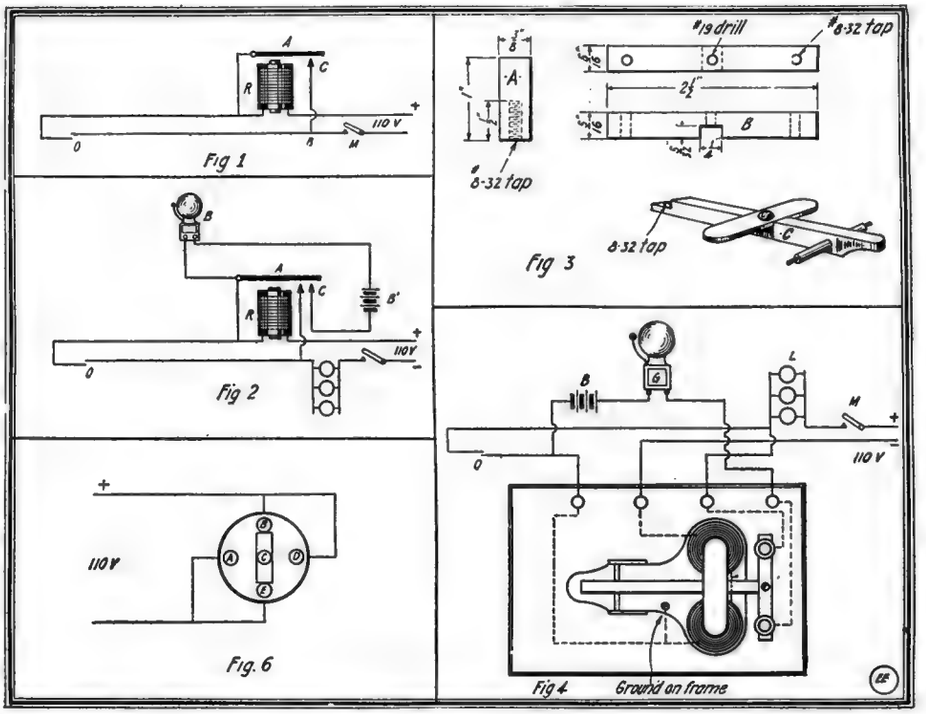
The small brass pillars A, should be screwed onto the base in such a position that when the armature is pulled down, the adjusting screws hit the centers of the pillars. The screws must be exactly adjusted so that each makes contact with its pillar. If one is screwed down too far, the other will not touch its pillar or front contact. This should be thoroly tested by an electric circuit. The magnets when energized should draw the armature down so that *both* front contact circuits are closed. Lamps or bells may be used to test the continuity of the circuit at the contacts.

Two additional binding posts will be needed as shown in Fig. 4. The wiring on the instrument proper is made as indicated.

The reader will see the advantage of this type of burglar alarm over the continuous ringing bell, because the alarm may be immediately shut off by a switch, and be ready for another alarm an instant later, whereas with the continuous ringing bell an armature must be lifted by hand and the alarm reset.

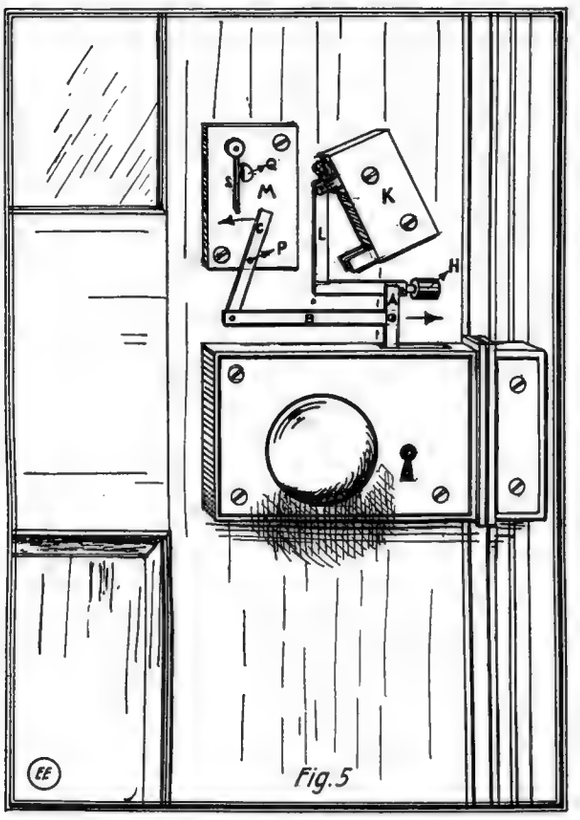
A few auxiliary contrivances may also be made in connection with the burglar alarm. The simple burglar alarm may be set from inside the house. When a person leaves, and opens the door it will ring, but stop when he closes it. This, of course, cannot be done with the alarm described herein, and a means must be employed to set the alarm *after* the person has closed the door and is outside. The main switch may be put outside the house and closed when leaving, but this is sometimes undesirable where there is no good means of concealment.

The author has devised a little contrivance wherein the alarm is set from the outside *when the key is turned in the lock*, in conjunction with another device which rings



Working Drawings and Diagrams for Constructing a Really Reliable and Particularly Effective Burglar Alarm Apparatus, Employing the "Stick Relay" Principle. Many Other Applications of This Relay Will Suggest Themselves to the Experimenter.

the alarm as soon as the key is again turned in the lock to open the door. Thus not only will the alarm ring when the door is actually opened, but the turning of the key will start it. The reader can arrange to ring the alarm by so much as inserting a key in the lock, if he has a contact insulated from the lock frame, and which will touch the frame by means of a circuit thru the key. This latter is simple, but the two formerly mentioned are slightly more complicated.



Special Arrangement of Interlocking Switches for Controlling "Stick Relay" in Burglar Alarm System Here Described.

The bar A (Fig. 5) is pivoted to B, B is pivoted to C, while C is fastened to a base M by pin P. If A moves to the right or left B moves to the right or left. The movement of B causes C to travel in an arc of a circle. The upper part of C engages a stiff spring S, in its travel, but only for a moment; for when A has moved as far to the right as it can, C will be in a position to the left of S, and S, which will have ceased engaging C, will spring back to normal. When A is moved to the left, C will turn clockwise, again engaging spring S and carrying it to contact Q, causing it to touch Q. This closes the alarm circuit; only for an instant it is true, but long enough for the stick relay to operate.

The part A is rigidly attached to the lock lever of the lock, so that when the latter moves, A will move with it. When the door is locked by the key, C moves counter-clockwise and engages S so that S does not touch Q. Upon opening the door, however, S touches Q and the alarm is rung. These parts should, of course, be firmly covered over with a steel junction box attached with blind screws.

The method for closing the main circuit by means of the door key will now be described. In Fig. 5, it will be seen that the upper part of A engages a bar which is attached to the lever of a switch, K. When A moves to the right it will carry this lever along with it, closing the main switch for setting the alarm*. When the door is opend by the key, A will move to the left without carrying the switch lever with it, thus insuring the continuity of the circuit. The knob H is used for pushing the knife back against A, when the door has been opened.

When the author installed his alarm the greatest difficulty was to get people to set it.

To prevent anyone forgetting to close the main switch, a very simple but effective device was finally resorted to, so that the alarm is *always set,* can be shut off when it rings, and still, a moment after having stopt ringing, it is set again. The main switch, instead of being a knife type, is a two-way snap switch, connected as illustrated in Fig. 6. When the alarm rings and it is desired to shut it off, the switch need only be turned once. For an instant—the time it takes for the piece C, to snap from contacts BE to AD—the circuit will be opened, which is enough time for the stick relay's armature to be raised. The switch is immediately closed again which, however, does not start the alarm as previously explained.

The reader can, with a little ingenuity, arrange to have even the turning of the door knob start the alarm. This should have a separate switch, however, so that it may be put in operation only at night, whereas the rest of the alarm may be in operation all the time.

Since no circuit is directly opened or closed at the pillars and since consequently no arcs are formed, the use of platinum contacts is unnecessary.

** The switch need not necessarily be the main switch; it may be any switch in series with the line.*

A ¼-TON LIFTING MAGNET.

An electro-magnet that is capable of lifting about 1,000 lbs., may be easily made. Its current consumption is about 5 amperes on 110 volts.

The body of the magnet consists of a circular piece of wrought iron or steel 7¾ inches in diameter and 29/16 inches thick. The bottom of the body should be machined true and a circular groove turned out in it to fit the magnet coil. The outer end of the groove is counterbored 1/16 of an inch deep by 1¾ inches wide, to fit a brass ring which keeps the coil in place. The ring is held in position by eight small flat-head screws. When fastened in place, the screws and brass plate should be slightly below the surface of the magnet body.

To support the magnet, three screw eyes of 3/16 inch stock should be provided and fastened in three tapt holes equally spaced in a 5 in. diameter circle, or one ⅜ inch stock screw-eye may be placed in the center as shown. For winding the wire coil, a wooden form or spool must be provided. It is made with a cylindrical core 3½ inches in diameter by 1½ inches long and slightly tapered, so that the coil may be easily removed when finished.

The flanges of the spool are 7⅛ inches in diameter wooden disks fastened on the cylindrical piece so as to be easily removed. The spool is mounted on an axle or between both centers, to allow it to rotate while winding the coil. About a dozen strips of insulating tape are equally spaced around the spool and tied or pasted in place, fitting length-wise with the spool centers and up along the inner side of both flanges.

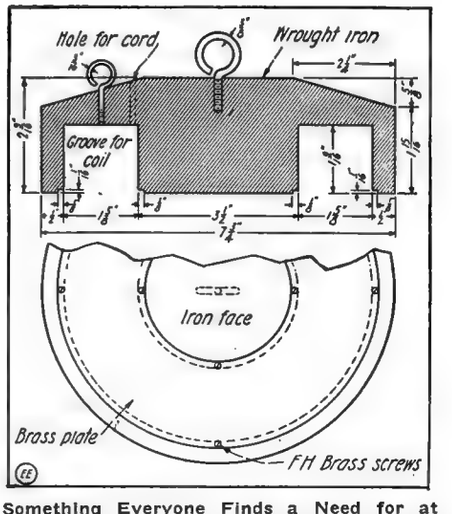
The coil (for 110 volts D.C.) will require about 7 lbs. of No. 20 gage wire, single cotton covered, or 7 lbs. of No. 23 gage wire for 220 volts, D.C.

In starting, about 1 ft. of wire must be allowed for a magnet lead which is past thru a hole near the center of one of the flanges. Each layer should be insulated with a heavy coat of thin shellac. When the winding is finished, about 1 ft. of wire must be left for the other lead. The strips of tape can then be brought over and pasted together to hold the coil in shape and insulate it from the magnet body. Several turns of the tape are then wound around the outside of the coil. The coil may then be left in a warm oven for about a day to let the shellac harden.

The magnet leads are spliced to a piece of heavy lamp cord. A ⅜ inch hole should be drilled in the top of the magnet casting for the cord and bushed with a fiber insulating tube. The coil should then be placed in the magnet body; if it has any play, several extra layers of tape can be wound on the coil to keep it sufficiently tight. The brass plate is then fastened in place.

To suspend the magnet, three equal lengths of chain are attached to a supporting ring; the loose ends are fastened to the screw eyes to keep the magnet level. The cord is then attached to a plug to make a connection with a 110 volt direct current circuit. It is not adapted for operation on alternating current circuits.

Contributed by J. LWAK.



Something Everyone Finds a Need for at Some Time Is a Good Lifting Magnet. Here Are the Details for Building an Efficient ½-Ton Electro-Magnet for Use on D.C. Circuits.

FLY PAPER.

Resin	8 parts
Castor oil	6 "
Glycerin	3 "

Dissolve the resin into the other two ingredients by the aid of heat. When they become a liquid spread on parchment paper by means of a brush.

"MOSQUITO CHASERS."

Oil of pennyroyal	1 oz.
Castor oil	3 "
Alcohol	6 "

Mix together and apply to parts of body exposed to the mosquitoes and they will not bite or come near it.

Contributed by ROBERT THOMPSON, Jr.

More About the "Perpetual" Electric Clock

By HOWARD W. LEWIS
Chairman Stanford University Branch of A. I. E. E.

THERE appeared in the June, 1916, ELECTRICAL EXPERIMENTER, a description of a proposed perpetual electric clock and, in August of the same year, an explanation of why the same would not operate indefinitely. That the plan is entirely feasible, provided a small amount of energy be supplied from some outside source, may be seen from the following description and illustrations of a similar device recently constructed at Stanford University.

In connection with some research work in Aerodynamics, need arose for an instrument which would close a battery circuit momentarily at *one second intervals.* As a substitute for a standard *seconds* pendulum, an electro-magnetically actuated clock was built which is capable of performing the desired service very satisfactorily.

In Connection with Some Research Work in Aerodynamics Need Arose for an Instrument that Would Close a Battery Circuit at One Second Intervals, the Apparatus Shown Having Fulfilled the Requirements Very Satisfactory. As a Test It Was Run for 24 Hours with a Deviation of a Few Seconds Only.

The photographs show the construction clearly. The details may be seen from the drawing. The frame is of small iron pipe and the table of thin steel plate. The pendulum consists of a round steel rod with two attached weights. It is hung on thin flexible steel springs from the short piece of angle iron shown, thus being free to swing with a minimum of friction.

The period, that is, the time of one swing of a pendulum, depends upon its length and the distribution of its weight. Near the bottom of the pendulum rod is a large iron cylinder (part No. 7) which may be moved up or down. The upper end of the rod is threaded to receive the nut, 16. Coarse or fine adjustment of the periodicity is thus secured by shifting one or the other of these weights.

On top of the plate is mounted a Veeder stroke counter, actuated thru links from the pendulum rod. This device, together with a stop watch, facilitates the calibration and adjustment of the clock.

A solenoid consisting of 2,700 turns of No. 26 B. & S. gage insulated copper wire is attached to the lower part of the frame. To the bottom of the pendulum is fastened a bundle of closely bound iron wires. This curved plunger moves in and out of the solenoid as the pendulum swings. The coil is energized from either the 110 volt lighting circuit with a lamp in series therewith, or from 3 dry cells without the lamp.

It is necessary, of course, to have some arrangement which will close the circuit thru the solenoid when the plunger is moving toward it, and open the circuit when the plunger is moving away. Accordingly, a six-tooth ratchet-wheel is fitted on a short horizontal shaft, and a commutator having the same number of brass and of fiber segments of equal width, is placed beside it. The shaft is mounted in plain bearings on top of the plate. To the pendulum rod is attached a flat link with a hook on its outer end, which engages with the ratchet-wheel and turns it one-sixth of a revolution for each alternate stroke of the pendulum. A copper leaf brush bears against the commutator from below. When the plunger is moving away from the solenoid and the hook is consequently reaching forward to pick up the next tooth of the ratchet-wheel, this brush rests on a fiber segment and the circuit thru the coil is open. On the return stroke, however, the hook pulls a live (brass) segment under the brush and current flows into the coil, which thus exerts a powerful pull on the plunger. Before the plunger reaches the end of its travel, a dead (fiber) segment rolls under the brush, the solenoid releases its pull on the plunger, and the pendulum swings back to repeat the cycle. The relative positions of the ratchet-wheel and commutator are adjustable on the shaft, so that the time of excitation of the solenoid can be placed at any desired point in the stroke of the plunger. An adjustable condenser of several microfarads' capacity is used to eliminate the spark between commutator and brush.

The secondary circuit, for whose operation this clock was built, is closed once each cycle between a phosphor bronze spring and the pendulum. The duration of the closure of this circuit can be adjusted by turning the screw (see details, part No. 19).

Considerable time and attention was given to designing this mechanism along correct principles and it has been very carefully constructed. The results attained justify the trouble involved. After a preliminary adjustment, a continuous run of 24 hours' duration showed a deviation of only *a few seconds* from a standard clock. Furthermore, it closes the secondary circuit at regular intervals, quite as well as a standard *seconds* pendulum *costing several hundred dollars.*

The original design of "Perpetual Motion" Clock involved the action of a swinging permanent magnet, which, as it swung into the coil, was supposed to develop sufficient energy to keep the clock going forever.

Upon request of the Editors, the author made a quantitative electrical measurement upon this device. For one thing he soon discovered that operating it upon batteries was too expensive, as it is now in continuous service eight, and often more hours per day. It is now operated thru the medium of a bell-ringing transformer. The secondary circuit which it operates is energized by batteries, however.

The point was raised as to the magnitude of the induced current in the coil.

In order to answer this question the author made a simple test which convinced him that the transient phenomena referred to are inappreciable compared with either the normal current thru the solenoid, or the current in the secondary (battery) circuit. These experiments were as follows:

(A) Solenoid entirely disconnected from the source, then connected directly to the terminals of D. C. milli-ammeter. No effect was produced on ammeter needle when the plunger was rapidly moved in and out of the solenoid. Same absence of effect noted when telephone receiver was used as current detector. Very slight deflection when sensitive ballistic galvanometer was used as current detector.

This is exactly what might be expected, since there is no field produced by the solenoid, as there is no exciting current thru it. I take it that what small current there is induced in the solenoid is due to the rapid motion thru it of the minute remanent field in the plunger. However as this is composed of a bundle of fine, *soft iron* wires, this residual magnetism is very small.

(B) Solenoid connectly directly (without ratchet wheel or commutator) to D. C. source; current in the circuit as indicated by milli-ammeter was 0.26 amp. Plunger rapidly moved in and out of the solenoid by hand. Effect: When plunger was forced *in,* current *decreases,* while the plunger was moving, about ½ milli-ampere. When the plunger was drawn *out,* current *increased, while the plunger was moving* about ½ milli-ampere. As soon as the plunger was stopt from moving, or as soon as it had moved out of influence of the solenoid, this transient current increment or decrement stopt and the current returned to its normal value in the circuit, as determed by Ohm's law, *i. e.,* 0.26 amp.

This again is exactly in accordance with the theory involved, that is, when the

plunger was moving into the solenoid the flux threading the latter was increasing at a rapid rate, due to the decreasing reluctance of the magnetic circuit, the magnetomotive force meanwhile remaining constant. This change of flux induced a voltage in the turns of the solenoid which tended to oppose the E.M.F., which was forcing the current thru the coil; in other words it is the well-known law $L = \frac{di}{dt}$.

It is exactly analogous to the similarly induced counter E.M.E. which arises in a coil to oppose the flow of current therein when the coil is first connected to a source of continuous voltage. Due to the fact, however, that the movement of the plunger could not under any conditions compare in rapidity with the rise of current in an inductive circuit, this counter E.M.F. is undoubtedly very much smaller than it would be if the solenoid permanently surrounded the core and the current were then establisht in the coil.

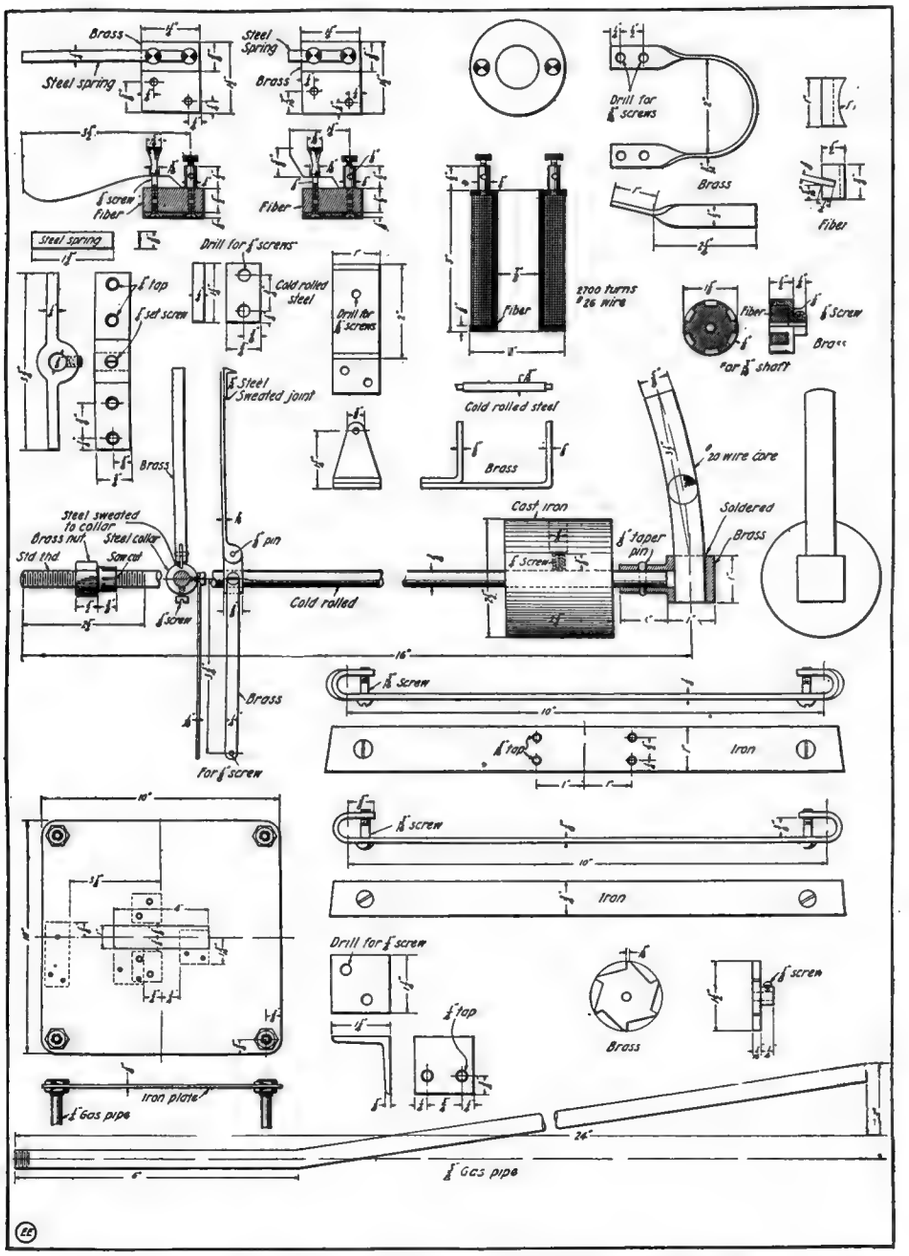
A moment's reflection will explain the observed phenomena when the plunger was drawn out of the solenoid along a very similar line of thought. It is exactly analogous to the arc that follows the opening of a switch in an inductive circuit. The collapsing magnetic field induces a voltage in the coil which tends to maintain the current.

[*Of course if the moving core had been of steel, powerfully magnetized, the effects noted would have been much more pronounced.*—Ed.]

WHAT TO DO WHEN ACIDS ARE SPILLED.

The safest course is not to spill the acid; the next best is to apply an alkaline solution at once, or cover with chalk. It is a good plan to keep a jar of strong washing soda solution always ready in case of emergency. The reason for using a jar instead of a bottle is that the solution can be poured over the spilled acid more quickly. A loose cardboard cover—the lid of a box—will serve to keep out dust, and more water can be added when necessary to make up for evaporation. A cocoa tin containing crushed chalk should also be kept handy in case any quantity of strong acid is spilled.

Contributed by H. J. GRAY.

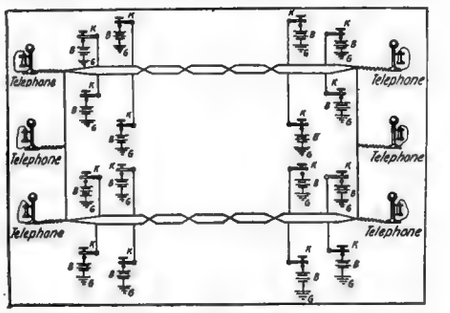


Details of All Parts Necessary to Build a Standard Seconds Pendulum for Use in Closing a Secondary Circuit at Exact Intervals, Et Cetera.

MULTIPLE TELEPHONE AND TELEGRAPH "PHANTOM" SYSTEM.

By L. R. W. Allison, Assoc., A. I. E. E.

The complementary relation between the telephone and telegraph system is particularly interesting and instructive. The accompanying diagram shows the method of wiring for multiple telegraphy as arranged by the American Telephone and Telegraph Company, indicating two telephone circuits, totaling four wires, which provide for the transmission simultaneously of a maximum of *three* independent telephone conversations and *eight* distinct telegraph messages without any interference with each other.



Schematic Diagram Showing How Three Telephone and Eight Telegraph Messages Are Transmitted Simultaneously Over Two Telephone Circuits. The A. T. and T. Co.'s Method.

The telephone circuit consists of two copper wires of approved construction, arranged in specific relation to each other and transposed at frequent intervals to reduce the inductive effects to a minimum. This pair of wires forms a metallic circuit, equipped with auxiliary apparatus, loading coils, etc., connected with a switchboard. As will be noted from the diagram, one wire of each pair is employed to form the third telephone circuit.

The telegraph circuit comprises one wire, grounded to the earth to make the necessary return, and which may be divided into several distinct circuits for the transmission of messages.

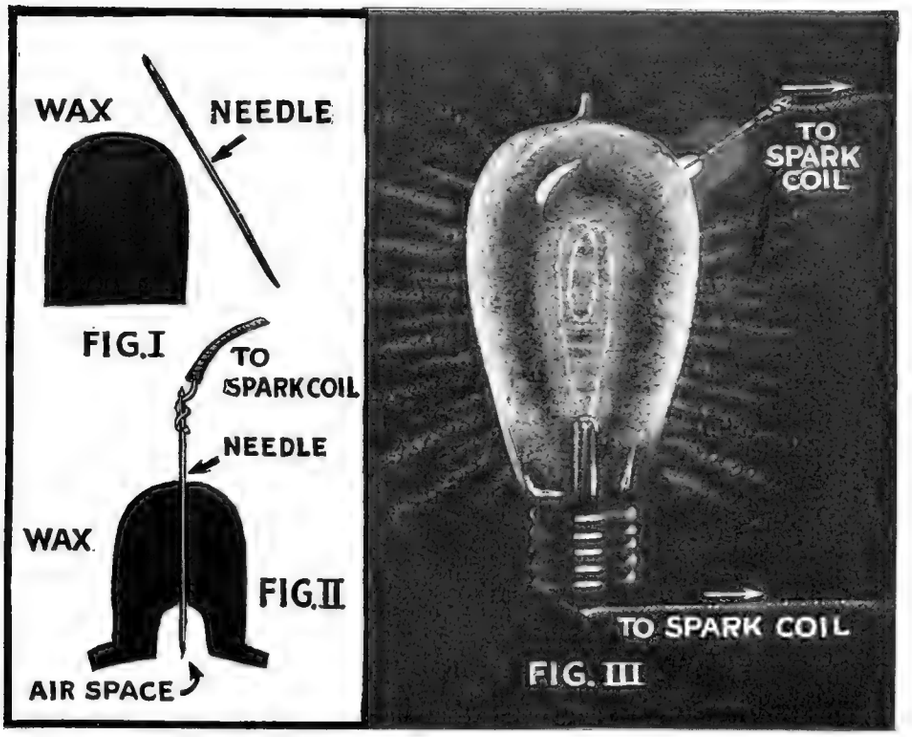
Each of the four telephone wires is capable of providing for a telegraph circuit at the same time the lines are being used for telephone service. The telegraph circuit is thus superimposed, and can be divided into a duplex system of two, four or eight working telegraph circuits, each of which may be employed for the transmission of telegraph messages. The telephone circuit proper can only be used for telephonic purposes by the two parties in direct communication, during the period of connection, as will be readily understood.

This complementary relation between the telephone and telegraph shows that telephone toll and long-distance lines may be used for telegraph purposes, but existing telegraph lines cannot be employed for telephone service until reconstructed and arranged in the manner indicated in the diagram.

In connection with this effective wiring arrangement it is interesting to note that this possible interchange of system and service brings about greater economy in the use of joint facilities of both telephone and telegraph plants, including both lines and terminal stations. Quite naturally, there are great advantages to be derived thru the use of a joint "wire plant," utilizing for both telephone and telegraph the operating facilities that would ordinarily be employed for a single purpose only.

A "GEISSLER TUBE" EASILY MADE.

Now that Geissler tubes are hardly procurable at any cost, I think that this article will prove of interest to all who have wanted a Geissler tube. Below are full



Details for Making a Home-Made Geissler Tube from an Incandescent Lamp and Appearance of Completed Bulb When Excited from Even a Small Spark Coil.

directions for making such a tube from a burned-out lamp bulb, providing the vacuum is not destroyed.

Take a piece of sealing wax and soften it so that it can easily be prest into a shape somewhat like that in Fig. 1. Then hollow out the center as in Fig. 2. Stick a needle thru the wax and while still soft and hot press the wax firmly against the side of the bulb as in Fig. 3, taking care that the wax is air-tight. Then connect one terminal of a 1 inch spark coil to the needle in the wax and the other terminal to the base of the lamp. Turn on the current and the spark will puncture the glass and the effect produced will be that of a high grade Geissler tube. The purpose of the hollow space in the wax is as follows:

This space is filled with air and when the spark punctures the glass, the air in this space rushes inside the bulb; in this way regulating the amount of air in it. Different colors are obtained with different air holes, that is, the larger the hollow space in the wax, the more air in the bulb.

When inserting the needle thru the wax, take care that it just touches the glass of the light bulb.

I have used this method of making Geissler tubes for years and I have found that it never fails to produce the desired results; as good as any tube I have bought. As the cost of each tube is very slight, and every tube made produces a different color, I have found it very interesting to make a great number of them.

Contributed by DAVID GOODMAN.

ELECTRIC IGNITER FOR FIRING A CANNON.

After having some experience with firing a cannon by fuses, lighting paper, and several other methods used, and getting a taste of powder at one time, I decided to make something which would be entirely safe and sane.

This apparatus costs but little, to which is added the fact that it is safe. It is a good thing to be used at a camp when firing a cannon for the raising and lowering of the flag, and is a safe way in which to fire a cannon on July 4th.

The apparatus can be placed as far as 75 yards away from the cannon. The things needed would be 1 push button, 3 dry cells, 2 binding posts, a small (¼" spark) spark coil, about 4 square feet of ½ inch poplar or pine, some shellac, screws and wire. I would recommend a section of a Ford coil which can be bought for a reasonable amount.

The inside measurement of the box should be 13½" by 8¼" by 3", the compartment for the batteries A, A, A, being 8¼" by 6½" by 3" separated by a partition, and then a compartment 6½" by 3½" by 3" or any suitable size for the spark coil which you have. The bottom and top should be made about ½" larger than the outside size of the box for the sake of appearance. When putting the box together all joints should be made by painting them with shellac and before it dries screw it down tight so it will be water-tight and damp-proof. When connecting the batteries leave plenty of wire for connections. The push button C, which is to complete the primary circuit to operate the coil, should be fastened on the cover above the compartment which has nothing in it.

The secondary binding posts "F" in the diagram should be fastened on the cover above the spark coil, and be sure the wires are carefully insulated from each other. After the box is made and put together give it about 5 coats of shellac to make it damp-proof. Shellac both inside and outside.

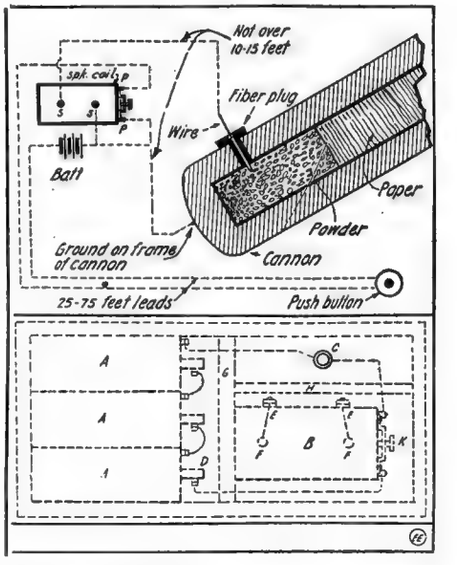
Before fastening the spark coil in the box be sure the coil is adjusted to its best secondary output when connected to the batteries which are to be used.

Up to about 75 yards this will fire a cannon with one side of the secondary grounded and the other secondary wire run through the air. This wire is supported by insulated wood sticks stuck into the grounds. Have the cannon grounded and the end of the wire about ⅛" from the one side of the fuse hole with powder around it. Then if everything is arranged as described, when the button is presst the powder will go up in smoke. For firing a cannon more than 75 yards from apparatus run one wire along on the ground and the other through the air. Connect the ground wire to the cannon. Fix the air wire as described before. This you will find is a very safe way to fire a cannon.

Code to Drawing: A, batteries; B, spark coil; C, push button on top of cover; D, primary circuit; E, secondary circuit; F, secondary binding post on top of cover; G, partition separating batteries; H, partition separating spark coil; K, spark coil vibrator.

In using this apparatus to fire a cannon with, make it a rule not to have the secondary leads over 20 to 30 feet long. These spark leads should be well insulated (at least one of them) and the primary push button wires can be of any length desired up to 50 or 75 feet, but 20 feet is usually sufficient.

Some constructors make their cannon to accommodate a standard gasoline engine spark plug at breech. Others arrange an insulated wire as shown in the accompanying sketch. This apparatus has been used very successfully by the Erie Y. M. C. A. and the Erie Boys' Club of Erie, Pa.



An Electric Igniter for the Toy Cannon Which Will Save Fingers, Mis-Fires and Premature Explosions.

Contributed by

GILBERT CROSSLEY.

HOW TO MAKE IT

This department will award the following monthly prizes: **First Prize, $3.00; Second Prize, $2.00; Third Prize, $1.00.**
The purpose of this department is to stimulate experimenters towards accomplishing new things with old apparatus or old material, and for the most useful, practical and original idea submitted to the Editors of this department, a monthly series of prizes will be awarded. For the best idea submitted a prize of $3.00 is awarded; for the second best idea a $2.00 prize, and for the third best prize of $1.00. The article need not be very elaborate, and rough sketches are sufficient. We will make the mechanical drawings. Use only one side of sheet. Make sketches on separate sheets.

FIRST PRIZE, $3.00

AN EFFICIENCY PLIER KINK.

Nature provides for average conditions only and she supplied us with a reasonably thick skin where it is called upon to do extraordinary amount of work or wear, but one of the spots neglected by bountiful nature is on the back of the index finger, between the first and second joints of the right hand. This is the spot that is charged with the duty of opening "diagonals," "long-nose," "goose-bill" and the common, ordinary, everyday pliers, and on this spot more blisters can be raised to the square inch than on any other spot on our anatomy.

The photograph clearly shows how to "save your skin" and while it will save more time than skin, it is our skin that we are most considerate of.

The spring that holds the legs apart should be made of spring brass, phosphor

Do You Want to Save Your Skin and Your Temper? Then Simply Fit Your Pliers with a Steel or Bronze Spring Like That Shown and Your Worries Will Be Over.

bronze or German silver and it is soldered to one leg, or if soldering offers any difficulty the spring may be riveted to the leg.

This kink is particularly useful in telephone exchanges in trimming terminal racks or cable and relay work, where it is necessary to cut and trim wires by the hour and which operation wears off considerable "bark." The kink also allows the use of all fingers for pressure on the legs.

Contributed by
FRED'K J. SCHLINK.

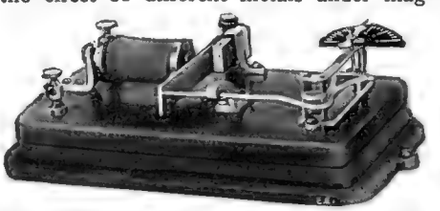
A "BAMBOO" FLASHLIGHT NOVELTY.

A distinct and useful novelty in electric flashlights is here shown and described. To make it, first secure a battery for a tubular flashlight. A piece of bamboo with an inside diameter the same or nearly the same as that of the battery is then obtained. The length of the bamboo is slightly greater, say an inch and a half, than the battery. The bamboo must have a joint about a half inch from one end. A hole is bored thru the center, just large enough to permit the flashlight bulb to fit tightly. A piece of bright tin, shaped right, is placed around the bulb to act as a reflector. A cork is

SECOND PRIZE, $2.00

A GAGE THAT INDICATES RELATIVE MAGNETIC ATTRACTION OF METALS.

The experimenter may often want to test the effect of different metals under mag-



With This Simple Home-Made Testing Device the Amateur Can Make Interesting Investigations of the Relative Magnetic Attraction of Various Metals, Both Ferric and Non-Ferric.

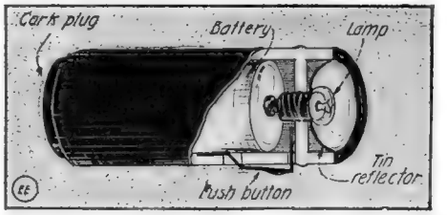
netic influence and an instrument, constructed by the writer, to determine this particular effect is shown in the accompanying illustration. The action of the apparatus as shown in the photo is very evident. As soon as a current is past thru the electro-magnet, the metal strip to be tested is either attracted or left neutral. In some metals as iron or steel, the armature or testing strip, will be moved considerably, but other metals like copper, lead, zinc are not affected at all. The effect of the magnet upon these latter metals can, however, be easily detected by so constructing the indicator that it will register the least perceptible movement of the armature. It is quite evident that the slightest movement of the rod will move the pointer over a considerable distance. By passing AC thru the magnet coil the relative magnetic repulsion of metals may be tested.

The indicator arrangement may be constructed from an old steam gage or clock works. The pivot block can be obtained from an old bell. Care must be used in making the instrument so that there is very little friction in the pivot rod support or in pinion and gear of the indicator.

Contributed by MARK SLABODNIK.

placed at the bottom to keep the battery from falling out. The contact is made as shown in the diagram, by means of the brass spring.

Contributed by EDMUND ANGLIN.



A Distinct Novelty in Flashlights—It's Made of Bamboo and Will Make a Very Attractive Gift or Favor for Parties and Dinners.

AN EMERGENCY FUSE PLUG.

Here is a little idea of my own on an "Emergency Fuse." Take an ordinary attachment plug and connect the terminals

THIRD PRIZE, $1.00

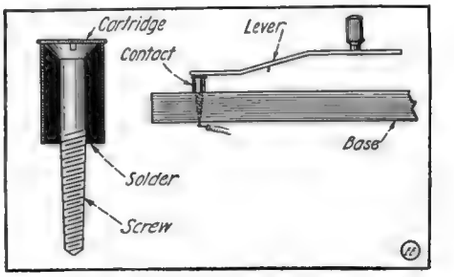
A SUBSTITUTE FOR SWITCH CONTACT POINTS.

When in need of switch contact points, old used .32 or .25 caliber cartridges come in handy. The "Radio-bug" with a lean pocketbook can construct these at practically no cost.

First clean the inside of the cartridge shell from all dirt, by using a small penknife or half-round file. Next take a common brass wood screw that will fit inside the cartridge and place it inside one which has been cleaned. Now pour solder in and you then have a serviceable contact point. It is perhaps better to put a drop of zinc chlorid on the inside of the cartridge to make the solder stick better.

If screws are used which will come thru on the rear of the base, wires may easily be soldered to them.

Contributed by G. GRANT WAITE.



Save Your Cartridge Shells, Boys. They Make Good Switch Points, if a Wood or Machine Screw is Firmly Embedded in the Shell by Means of Solder. The Leads May Be Soldered to the End of the Screw.

A PECULIAR STATIC ELECTRICAL PHENOMENON.

I am a stenographer, employed in an architect's office, and my duty is to write specifications, ten copies at a writing. In writing, a static charge is generated on each of the carbon papers, which is separated from the next by the white paper. On separating the carbons from the white papers, which is done by pulling the ends of the carbons, which protrude beyond the white papers, with one hand and the white papers themselves with the other hand, some of the charges are neutralized on separation; sharp crackling being indicative of this. I usually place all of the carbons onto the machine, after which I draw quite a long spark from any part of the machine into my knuckle.

At first I received the shock unexpectedly after bringing my hand near the charged machine, as I had formed a habit of placing the carbons onto the machine after each writing. After investigating the matter, I found that the mysterious "what-is-it" was developed in the machine.

Contributed by WM. LESKY.

with a small piece of common screen wire. A single strand of wire will pass about 3 amperes; 3 strands 6 amperes, and 6 strands about 10 amperes.

Contributed by HUBERT YEAGER.

Where the Radio Amateur Fits in the U. S. Naval Reserve

By M. B. WEST, RADIO GUNNER, U. S. N. R. F.

THE amateur has at last an opportunity to be of real service to the Government, and one that will not in any way interfere with his career in civil life. The argument that the amateur would be of inestimable benefit in time of war has so often been made that it has at last been recognized. Yet it is clear to anyone who gives it a moment's thought, that without at least some preliminary training most amateurs would fail miserably if suddenly placed in charge of a large radio station.

It is with the intention of remedying this situation, that the Class 4, Naval Reserve, has been created. In as far as possible, it is hoped that amateurs enrolling in the reserve will at once ask for a short period of active duty so as to become familiar with the requirements of the radio work of the navy. Then they will return home, and it is hoped will join one of the drill routes that have been organized in connection with the Naval Stations. The purpose of these drill routes is to perfect these amateurs in handling radio business according to the rules of the navy.

And think what a difference it would make in amateur working conditions if all amateur business was handled in an orderly and thoroly efficient manner!

These drill routes will be placed under the direction of an officer of the naval reserve, and every effort will be made by them to assist amateurs in solving the many puzzling problems that arise in connection with their stations.

It is not necessary to enroll in the reserves, to join in the drill, but it is earnestly hoped that all will do so. So far this feature has been worked out more completely in the Middle West in connection with NAJ, the naval station at Great Lakes, Illinois.

The Class 4, Naval Reserve, is a very liberal organization, and creates an opportunity that seems especially adapted to amateur needs. To enroll, you must be an American citizen, be able to send and receive at the rate of ten words per minute, and be able to pass the usual physical examination. On enrollment members will receive a yearly retainer fee of $12.00, until such time as they have perfected themselves sufficiently to be able to handle their work in a manner on a par with regular naval practise. After such time they will receive an annual retainer pay equal to two months' pay of their corresponding grade in the regular navy. In addition they receive traveling expenses to and from place of training—uniforms, meals and lodging and the regular pay from the time they leave their homes until they return to them. This is all clear money, and should be particularly attractive to students and others, as it gives an opportunity for training and also saving during vacation period.

One feature that is especially liberal is that a member of the reserves will be discharged at any time during peace at his own request. Active service is not compulsory, and orders to active duty are only issued at the request of members themselves, and will be arranged so as to interfere as little as possible with your regular business. The only time the reserves can be called for active duty, is in time of war, and it is intended to use them at the less important land stations so as to relieve the regular officers and men for their active war duties. Information in detail can be secured from the nearest naval recruiting officer, who will be glad to give you any information you may require.

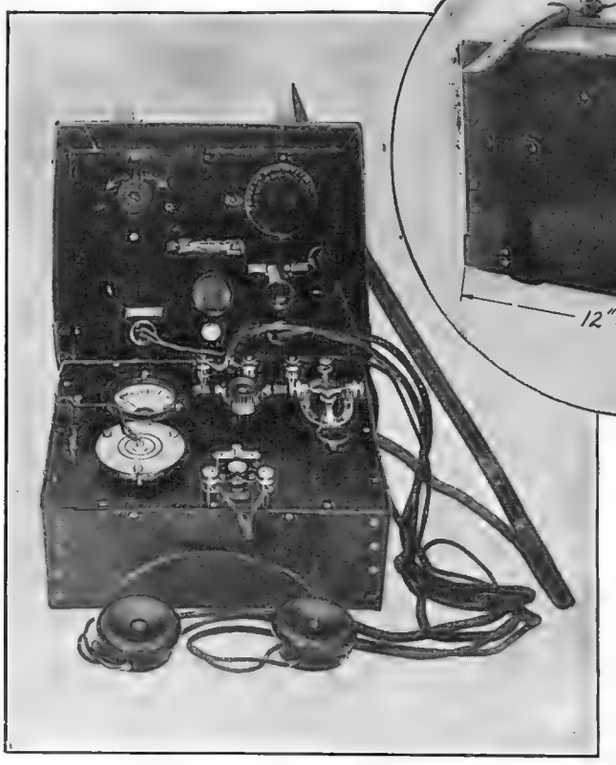
Here is an opportunity to prepare yourself so as to be of real assistance to the Government, and at the same time be well paid while doing so.

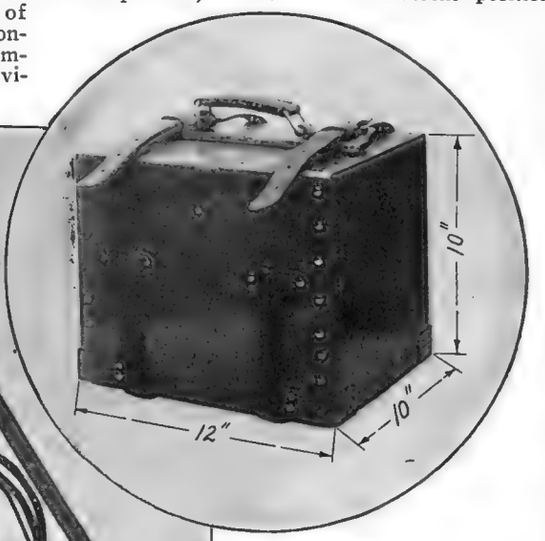
As it is the first appeal to the amateur, if we are to live up to the reputation that has been made for us we should respond gladly and willingly. We can assure you that you will be pleased with the treatment you receive while on active duty and will return home with a much more friendly feeling towards "Uncle Sam" and his navy.

AN EXTREMELY LIGHT-WEIGHT RADIO TRANSMITTER AND RECEIVER.

The illustrations herewith show one of the latest types of portable light-weight, radio transmitter and receiver, adaptable for both military and civilian duty.

This outfit was designed and built by Mr. A. B. Cole, a prominent radio engineer of New York City. The transmitter is stationed in the main compartment while the receiving outfit is placed in the cover of the case, which is a substantially built fiber affair measuring 10 x 10 x 12 inches. It is equipt with heavy carrying straps. The transmitting set comprises the following:—A high tension spark coil placed within the case and which is used to charge a condenser thru a special quenched spark gap. This is seen on top of the panel, indicated by the horizontal circular disc. This gap is of the quenched type and is composed of two perfectly parallel plates. The top electrode is connected to the helix by a flexible conductor. A special independent vibrator is connected with the primary of the induction coil and this is located behind the forward binding posts. It is an essential feature that the frequency of the emitted wave have a high pitch, musical tone and with the aid of this vibrator this is readily accomplished, which was heretofore impossible, due to forced action of the spring constituting the common form of vibrator.





One of the Latest Compact Radio Sets Designed Especially for Field Military Service. It Has a Powerful Transmitter Operating on a Storage or Dry Battery.

The tuning inductance consists of a number of turns of wire placed on a frame, the size of which is equivalent to that of the inside of the dimensions of the box, so that it does not interfere with any of the other inclosed instruments. Taps are led off at four different positions, and are terminated in four plug receptacles which are placed at the left of the panel. A flush type hot wire ammeter is also secured to the Bakelite control panel. The antenna change-over switch is shown in the background and the transmitter key at the right.

The receiving apparatus is mounted on a separate Bakelite panel and contained in the case as illustrated. This receiver comprises an inductive coupler, with a fixt secondary and tuning is accomplished by means of a secondary variable capacity. This latter is controlled by means of a graduated handle noted at the upper right hand corner. An enclosed mineral detector is employed with this set; it is placed in the center of the cabinet. The round instrument below the detector is a high frequency buzzer used for testing purposes, and the button directly beneath the buzzer is used to start the buzzer. The plug to the left of the push button inter-connects the telephones with the set, while the plug to the right interlinks the antenna and ground thru the sending apparatus. The switch to the left of the sending key connects the antenna with either the sending or receiving instruments; by turning to the left, the receiving instruments are connected, and to the right is for transmitting.

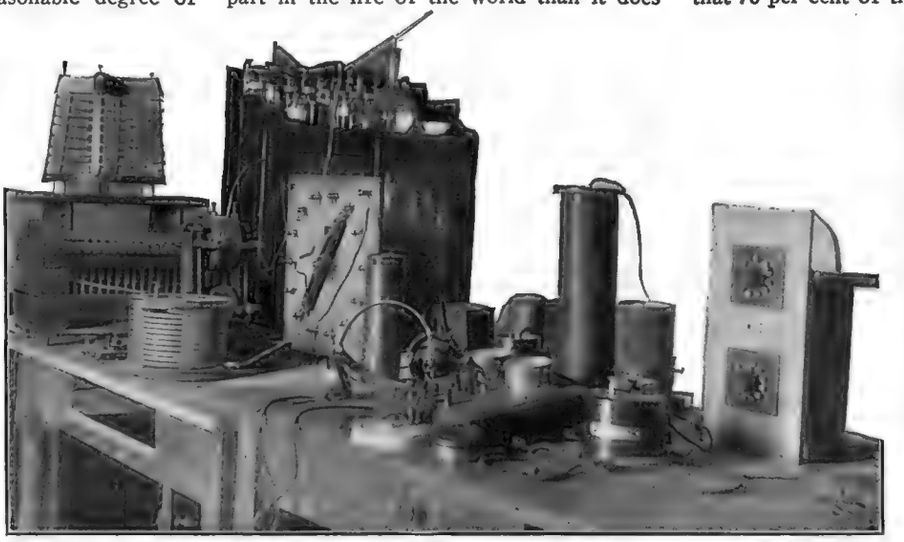
Amateur and Experimental Radio Research

By RAYMOND FRANCIS YATES

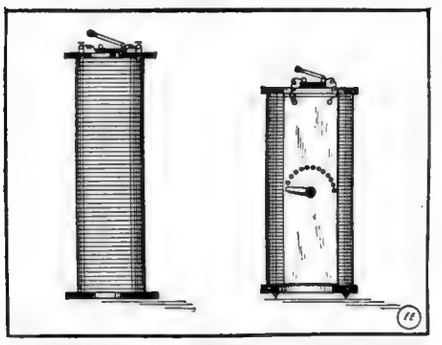
PART I.

OF all the present-day fields of scientific endeavor, there is probably none more promising or productive than that of wireless. It is hardly correct to say that wireless is in its infancy, but the art has by no means reached any reasonable degree of perfection and the work yet to be done is unbelievably vast and important.

Of the multitude of wireless amateurs in the United States, there is a surprisingly small number of serious-minded experimenters who have really entered the field for anything more than an interesting hobby. Many experimenters are inclined to think that wireless research entails such a great expense and involves such costly apparatus that it is quite beyond their means. It is the purpose of this paper to disprove this erroneous opinion and explain how it is possible for every amateur to exercise his inventive talent in the great field of radiocommunication. There seems to be a lack of real, scientific enthusiasm among the amateurs of the United States, especially in regard to the perfection of the art, and it is the object of the author to try and offer a few suggestions with the hope that these amateurs will regard their work in a more serious attitude with the intention of developing something original. I have talked to many experimenters who thought that they had conceived a valuable idea, but either they did not possess the courage to develop it or they thought it was beyond their ability. If de Forest had had the same attitude, we would not have the Audion; if Marconi had lacked unflinching inspiration and courage, probably de Forest would not have needed to invent his Audion detector at all. Among the 400,000 and more radio experimenters in the United States, there are undoubtedly many Fessendens, Marconis and de Forests, who either lack courage or enthusiasm to enter research work.



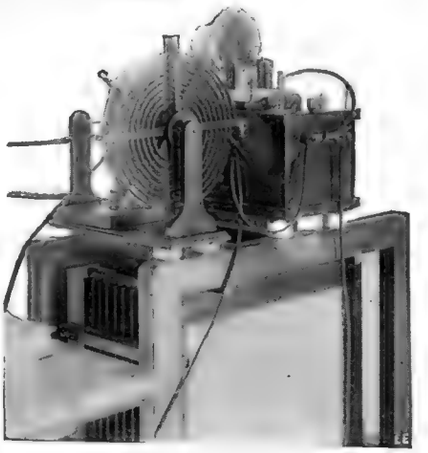
A Typical Radio Experimental Laboratory Equipt with a Variety of Condensers and Inductances, as Well as Other Supplementary Apparatus with Which Many Valuable Researches Can Be Made.



If You Make Up Loading or Other Inductances, Take the Trouble to Either Measure or Calculate the Inductance in Micro-Henrys or Centimeters. It Always Pays.

Possibilities of the Field.

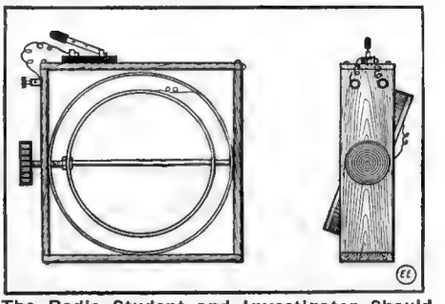
The possibilities of development in wireless are limitless. We have just entered a new era—the *Wireless Era*. We must remember that the application of wireless is not necessarily limited to the transmission of intelligence. In the future this will constitute the smallest part of it. We have seen the birth of developments that tell us in no uncertain terms that the science of radio is destined to play a far greater part in the life of the world than it does today. The wireless transmission of power, radio control of mechanisms (radio tele-mechanics), the development of radio-telephony, directive communication, the perfection of the high frequency alternator, and the elimination of interference, are but a few, a very few, of the problems to be solved. There will be a day, in the not far distant future, when an audience in New York may sit and listen to a concert being played in Paris *via radio*. Nikola Tesla tells us that within 25 years we will be sending radio controlled boats to any port of Europe without a man on board! We may put much faith in statements made by Tesla, as his accomplishments are many and great. If it is possible to control vessels via radio, why will it not become possible to control airships, trains and automobiles? It would indeed be a superficial observer who would conclude that radio is anything but a fruitful field for those who desire to enter into penetrating and productive investigation.



A Good Type of Experimental Radio Transmitter Which May be Used with a Phantom or "Dummy" Antenna.

Knowledge Necessary for Research Work.

Contrary to the general opinion possest by experimenters, it is next to impossible to successfully enter into research work without an elementary understanding of the fundamental principles of radiocommunication. It is indeed a deplorable fact that 70 per cent of the radio experimenters in the United States can not thoroly explain the theoretical basis of operation of one of their instruments. True, they can tell you that a variable condenser is used to tune with and to reduce "static," but the real "how" of its operation is hopelessly beyond them. These statements do not necessarily infer that to enter research work it is imperative that one be a radio expert or graduate engineer. Quite to the contrary. It is only necessary that one be familiar with the elementary theory under which the various elements of radio receptors and transmitters operate. This knowledge is absolutely essential and even then it is not necessary to go real deep at the start. It is not necessary to be able to explain in theoretical detail the unilateral conductivity of crystal rectifiers or the mathematical physics of the expanding hot-wire meter. One should be familiar, however, with inductance, capacity, resonance, damping, resistance, impedance, etc. One should know *why* a variable condenser will alter the wave length by changing the capacity of the circuit; why the inductance of a tuning transformer has the same effect, and why the quenched gap has a tendency to set up sustained oscillations. It is surprising how many suggestions present themselves when a working knowledge of the various instruments is acquired. Ideas then come fast and numerous. The moral here is—study! Read every article and book you can get hold of. If you don't understand it the first time, read it again. It would probably take you several years to work out the law of $W.L. = 59.6\sqrt{L \times C}$, but by reading the up-to-date magazines on the subject and elementary books such as the "Wireless Course" by Gernsback, Lescarboura and Secor, you can learn just why, for a given wave length, that when C is decreased, L must be increased, etc. None are so blind as those who won't see!



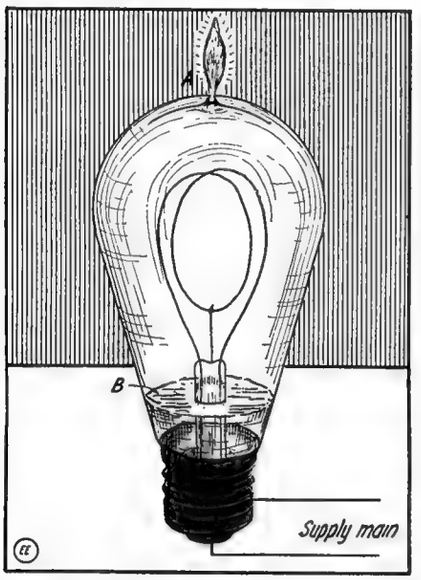
The Radio Student and Investigator Should Provide Himself With a Number of Variometers of Different Sizes and Known Inductance Values.

(*Continued on page* 218)

A PECULIAR EXPERIMENT WITH A LAMP BULB.

A curious experiment can be made with a 110 volt, 16 candle power carbon lamp. Anyone who has seen the tip broken off an electric lamp while burning has noticed that it soon becomes brilliant, then goes out.

For this paradoxical experiment, now break the tip A off as small as possible, but enough to let the air in, then fill up to B with gasoline. Connect the lamp in circuit to 110 volts, and the lamp will burn about ½ candle power. Now, tho this is only a 110 volt lamp and ordinarily in perfect condition, it would burn out in a very short time on a 220 volt circuit; connect it to a 220 volt circuit, and it will apparently burn at the same candle power or ½. When the lamp has burned for about three minutes on either voltage, place a match at the opening and a small and very white light will burn like a candle,



A Novel Experiment with an Incandescent Lamp Which Is Filled Up to "B" with Gasoline. When Connected to Live Circuit Gas Is Generated and May Be Ignited at A by a Match.

becoming stronger as long as the gasoline lasts, same depending on the size of the tip, but as soon as you open the switch, the light and flame go out.

Place the lamp in a horizontal position and the lamp acts the same as tho you had broken the tip while it was burning. It will only behave in this paradoxical manner while vertical, tip up and base down.

Contributed by
GEORGE C. MACLEAN.

FORMULA FOR WOOD'S METAL.

This silvery fine-grained alloy fuses between 151 and 162 deg. Fah., and is adapted to soldering, and mounting crystals as galena, silicon, etc., for wireless work.

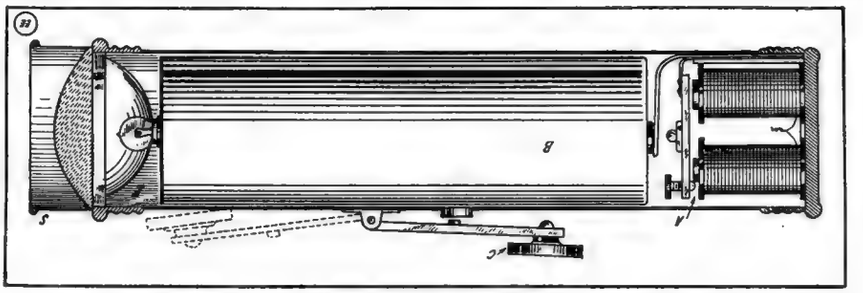
Tin .....2 parts
Lead .....4 parts
Bismuth .....5 to 8 parts

Contributed by
ALBERT W. WILSDON.

Due to the advent of the war, we are particularly desirous of obtaining manuscripts describing original and practical "Electrical Experiments."

MILITARY SIGNAL LIGHT AND BUZZER.

A very compact and serviceable arrangement of military signal light and tell-tale buzzer is shown in the accompanying illustration. It was developed by R. C. Avery, and is said by him to be particularly efficacious for flashing light signals at night; the tell-tale buzzer sounding for each dot and dash as they are sent out by the transmitting key or switch on the side of the battery case.



The Boy Scout Signal Corps Divisions Will Find This Combined Buzzer and Signal Light Outfit Very Light and Serviceable. Be Sure You Have a Good Lens to Start With, and a Parabolic, Well Polished Reflector.

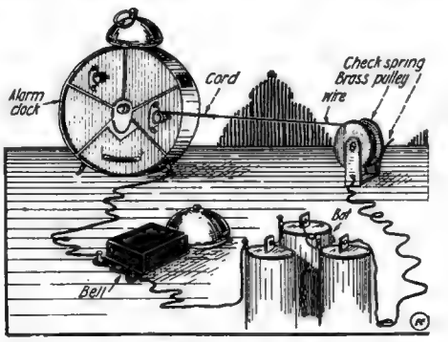
This idea should prove very useful to the signal corps division of the Boy Scouts. The present signaling device was found very efficacious compared to the acetylene lantern previously used in the United States Army signaling work, the electric lantern here illustrated having signaled over a distance of 5 miles at night and 2 miles in daylight.

The instrument as developed by its inventor measures 10½ inches in length by 2¼ inches extreme diameter. The transmitting key folds over so that when carried in the pocket it cannot accidentally close the circuit.

HOLY SMOKE! ANOTHER ELECTRIC ALARM CLOCK.

The illustration shows an electrically operated alarm clock of new design. One terminal of the battery is connected to a metal standard, holding a brass pulley, on which is wound a few turns of fine copper or brass wire. One end of the wire is fastened to a piece of cord, the other end of which is tied to the alarm winding key. The second terminal of the battery is connected thru a bell to one foot of the alarm clock.

The mode of operation is as follows: The circuit is open at the cord due to its non-conductivity. When the alarm rings, it winds the cord on it until the wire is drawn on to the key. This completes the circuit and operates the bell or any other device. The magnet wire is of course long enough so that when the alarm key has turned its full rotation there is still some wire wound around the pulley. Both the clock and the standard should be securely fastened to a suitable baseboard.



What! Ding-bust-it, if Here Ain't Another "Electric" Alarm Clock. The Inventor Arranges a String and Wire So That When Clock Key Turns, the Wire Is Finally Grounded, Closing the Bell Circuit.

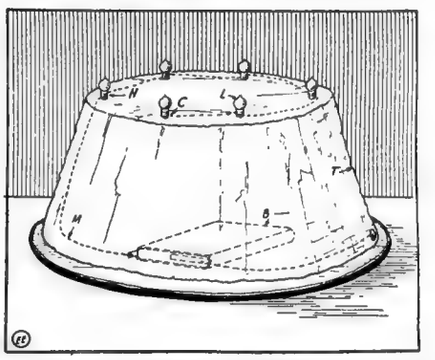
Contributed by
A. H. BEILER.

AN ELECTRIC BIRTHDAY CAKE WITHOUT THE DOUGH.

The materials required for this stunt are a tin pan, about ten inches in diameter and four inches high, a number of miniature-base colored lamps, and a source of current. After obtaining these, proceed as follows:

Mark off on the bottom of the tin pan, the desired positions of the lamps, and punch holes, H, at these points. The holes must be of such size that the screw base, C, of the lamps, L, will just fit in them. This done, turn the pan over and solder the No. 20 wires, M, to all the center connections of the lamps, and continue this wire to the source of current, which may be a flashlight battery or two, B, placed under the pan. If the source of current is a storage battery or a step-down transformer, the wires going to the same should be concealed. The hardest part of the work is now finished.

The icing is now to be put on the "cake" and in order to make it stick, paper should be pasted on the pan. The icing is spread smoothly over the paper up to and touching the lights. When hardened, this novelty will have all the appearances of a genuine iced cake with lights mounted in the top.



For Birthday Parties an Electric Cake Is Always Welcome. This One Is Made from a Tin Pan Iced Over. The Battery Is Placed Within the Pan.

Contributed by VICTOR DE FLORIN.

TO TRANSFER PICTURES TO WOOD.

Dissolve salt in soft water; float your photo print on the surface, picture-side up; let it remain about an hour. The wood should be of bird's-eye maple, or other light-colored hardwood. Varnish with the best copal or transfer varnish.

Take the picture from the water; dry a little between linen rags; then put the engraving, picture side down, on the varnished wood, and smooth it nicely. If the picture entirely covers the wood after the margin is cut off, so that no varnish is exposed, lay over it a thin board and heavy weight; leave it thus over night. If you wish but a small picture in the center of the wood, apply the varnish only to a space the size of the picture. Dip your forefinger in salt and water, and commence rubbing off the paper; the nearer you come to the picture, the more careful you must be, as a hole would spoil your work.

Contributed by V. C. McILVAINE.

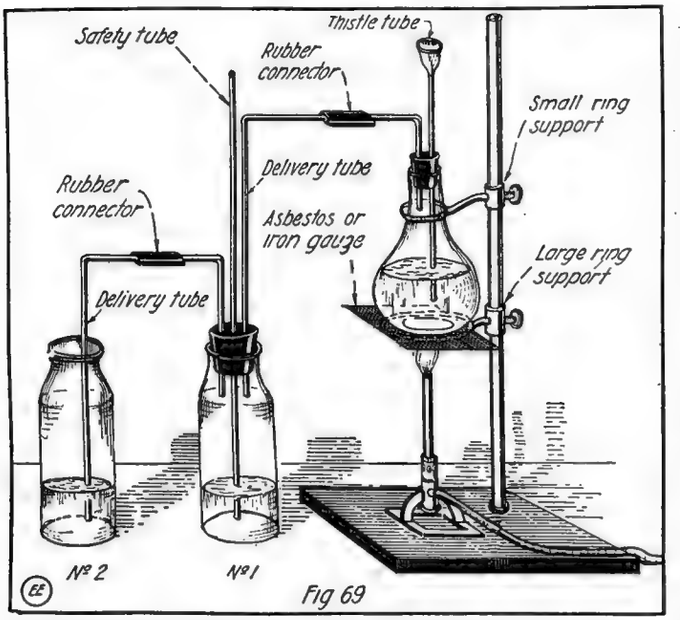
Experimental Chemistry

By ALBERT W. WILSDON

Fourteenth Lesson

HYDROCHLORIC ACID.

BASIL VALENTINE in the 15th Century first described the preparation by a process similar to the one now in use. He called it "Spirit of Salt." That which escaped from anything easily in intangible form was called a "Spirit." Thus *Spirit of Wine, Spirit of Wood,* etc., are indication of the crude theory of spirits so long in vogue. Hydrochloric acid being a gas which is liberated from salt when it is treated with Sulfuric acid, it was naturally regarded as a *Spirit of Salt.*



Experimental Apparatus Set Up for the Preparation of Hydrochloric Acid In the Laboratory.

Glauber prepared this gas in the 17th Century by treating Sodium Chlorid [Common salt, Na Cl] with sulfuric acid.

Priestly, in 1772, first obtained it in pure condition. He called it "Marine Acid Air."

Upon the theory introduced by Lavoisier, that all acids necessarily contain oxygen, Hydrochloric acid was for a long time believed to contain oxygen.

About 1810, Davy established the elementary nature of Chlorin, and hence the true nature of its hydrogen compound, Hydrogen Chlorid [Hydrochloric acid]. The correctness of his results became generally recognized shortly after. Many facts lead to the conclusion that Hydrochloric acid gas is composed of Hydrogen and Chlorin in such a ratio that its composition may be represented by the formula, HCl.

1. Hydrogen burns in chlorin, the only product being Hydrochloric acid gas.

2. When hydrogen chlorid [Hydrochloric acid] is decomposed by an electric current, equal volumes of hydrogen and chlorin are evolved.

3. When a mixture of equal volumes of hydrogen and chlorin is exposed to the direct sunlight, or to the action of an electric spark, the gases combine with explosive violence, and Hydrochloric acid gas is formed with no residue. Furthermore, the volume of the resulting gas equals the sum of the volumes of hydrogen and chlorin used.

4. When a given volume of dry hydrochloric acid gas is treated with sodium amalgam, the chlorin is withdrawn by the sodium in the amalgam, and a volume of hydrogen remains which is half the original volume.

5. No derivative of Hydrochloric acid is known which contains less hydrogen or less chlorin in a molecule.

6. The ratio by weight in which hydrogen and chlorin combine is 1 to 33.45. Hence, the lowest molecular weight of Hydrochloric acid is 36.45, a number which has been verified by several different methods.

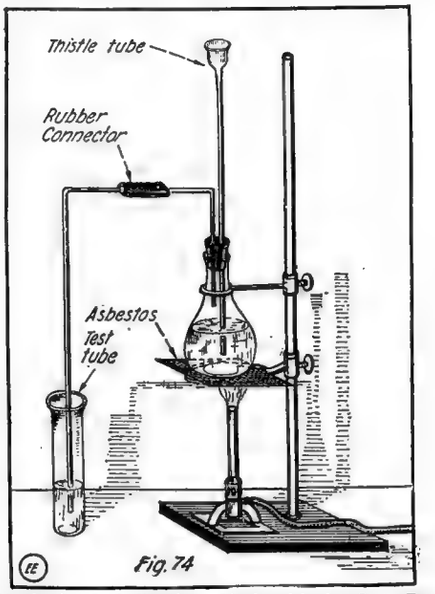
OCCURRENCE:

The free occurrence of Hydrochloric acid in Nature is rare, as its affinities are too strong. It occurs from the exhalations of active volcanoes, as Vesuvius and the fumaroles of Hecla. It is also a constituent of some streams and rivers which have their origin in volcanic mountains. It is found in the waters of certain South American rivers that have their source in the volcanic districts of the Andes.

The series of salts, derived from Hydrochloric acid, are widely distributed and of great importance. In general, they are crystalline, stable, and soluble [except Silver], tho some are decomposed by water, especially if evaporated with it. Common salt, Sodium Chlorid [NaCl] is the most important of the chlorids, and in fact is the parent substance from which almost all chlorin and its compounds are made, as well as all of the sodium compounds.

In the manufacture of Sodium Carbonat by the process in most common use, Salt is first treated with Sulfuric acid, by which it is converted into Sodium Sulfate. In this stage of the process, Hydrochloric acid is necessarily formed in large quantity. Formerly this was allowed to escape into the air, but the injurious effects which it had upon vegetation, caused laws to be enacted whereby the manufacturers were compelled to prevent the escape of this gas. The waste gases are now caused to pass thru towers filled with bricks so arranged as to present a maximum of surface, over which water is kept constantly passing. The gas dissolves in the water quite readily, and the solution thus obtained, which is sometimes somewhat colored, is the Hydrochloric or Muriatic acid of commerce. The discoloration is due to the presence of impurities, such as Iron and organic substances.

Hydrochloric acid forms a part of the digestive fluids of the stomach. The acid is supposed to be secreted in what is known as the *Border Cells,* whose exact functions are still unknown. The gastric juices of the stomach in normal condition contain about 0.33 per cent of free acid. Aside from the aid which Hydrochloric acid gives in peptic digestion, its presence is important, in that it destroys the germs of fermentation and disease, and probably dissolves some mineral salts. Its action in destroying germs permits the food to be stored in the stomach for some time without undergoing decay.



Method of Collecting Hydrochloric Gas By the Downward Displacement in a Dry Test Tube. See Experiment 79.

PREPARATION:

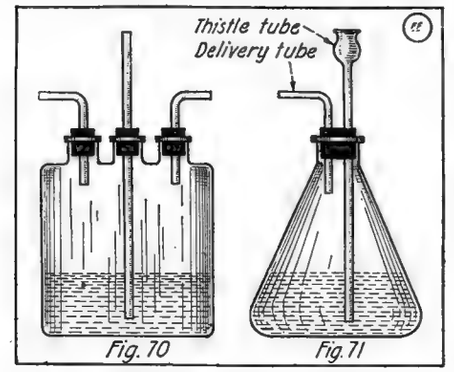
The method generally used in the laboratory is to treat common salt, Sodium Chlorid [NaCl] with Sulfuric acid. The reactions which may take place are:

[1] $NaCl + H_2SO_4 = HCl + NaHSO_4$
(Sodium Chlorid + Sulfuric Acid = Hydrochloric Acid + Hydrogen Sodium Sulfate)

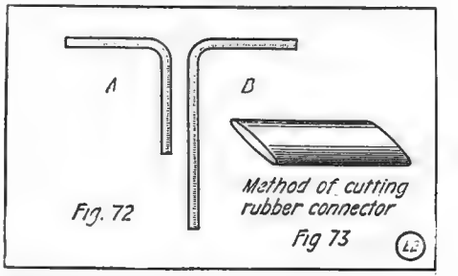
[2] $2NaCl + H_2SO_4 = 2HCl + Na_2SO_4$
(Sodium Chlorid + Sulfuric Acid = Hydrochloric Acid + Sodium Sulfate)

If an excess of acid is employed, as in the first reaction, a moderate heat is required, and a readily soluble salt, Hydrogen

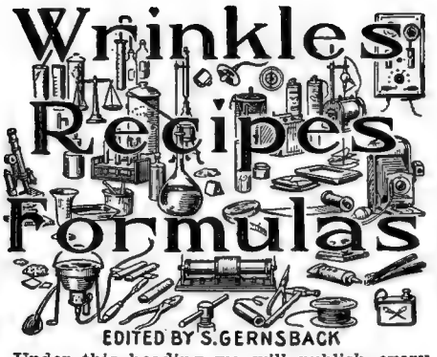
(*Continued on page* 220)



At Left—A Wolff Bottle With Three Necks: At Right—Erlenmeyer Flask Which May Be Substituted for the Florence Flask Specified.



Shape of Glass Tubes Used to Connect Up the Apparatus Here Illustrated and Method of Cutting Rubber Sleeves Diagonally to Make Them Slip On Tubes Easier.



Under this heading we will publish every month useful information in Mechanics, Electricity and Chemistry. We shall be pleased, of course, to have our readers send us any recipes, formulas, wrinkles, new ideas, etc., useful to the experimenter which will be duly paid for, upon publication, if acceptable.

HOW TO MAKE A CHEMICAL BALANCE.

The accompanying photo illustrates a chemical balance constructed by the writer While not being extremely accurate it nevertheless will measure quantities to the degree of accuracy generally demanded in an amateur's shop or laboratory. It is not difficult to construct and ordinary care being used, it can be made to weigh within a gram.

The illustration is self-explanatory, but a few words may not be amiss. To make it, first obtain a telephone ringer set as that shown in figure. It is not necessary to purchase a brand new one, but go to some electric or telephone repair shop where you may secure a ringer for less than fifty cents or even for nothing, possibly. Proceed to rearrange the different pieces so as to appear, after adding other parts, like that shown below. On the armature, solder or bolt a strip of metal, preferably aluminum, ½" x 7" and on the ends of this "beam" attach two circular 4" pans. Below one of the pans place a right angle strip and adjusting screw, in order to be able to make pans balance. Back of the instrument, after fixing on base, place a strip for an indicator.

Every Experimenter Needs a Small Balance for Weighing Chemicals On. Here's One Made from a Telephone Ringer Frame Fitted with a Set of Pans and a Scale.

Finished with shellac, this instrument will make a neat looking and useful little piece of apparatus for chemical or photographic work.

Contributed by MARK SLABODNIK.

"PER CENT" SOLUTIONS.

A table giving the weight in grains [avoirdupois] of any chemical substance required to make a per cent solution from 1 per cent to 50 per cent, based on the weight of one gallon of water at 40° F. = 8.33888 lbs. [avoirdupois], or one fluid ounce of water weighing 456.03 grains [avoirdupois].

For each fluid ounce of water take

For a	1	per cent solution..	4.66	grains
	2	" " ..	9.38	"
	3	" " ..	14.10	"
	4	" " ..	19.00	"
	5	" " ..	24.00	"
	6	" " ..	29.10	"
	7	" " ..	34.30	"
	8	" " ..	39.60	"
	9	" " ..	45.09	"
	10	" " ..	50.67	"
	15	" " ..	80.48	"
	20	" " ..	114.00	"
	25	" " ..	152.00	"
	30	" " ..	195.44	"
	35	" " ..	245.56	"
	40	" " ..	304.02	"
	45	" " ..	373.10	"
	50	" " ..	456.03	"

It should be noted that the above table applies to water, percentage solutions for other liquids would necessarily have to be figured on the weight of the particular liquid.

Percentage solutions are also, sometimes, made up from a saturated base. This method is incorrect unless it is so designated in giving the formula, that is, by stating in the formula *saturated solution base*. Such percentages are made by placing in the liquid used more of the chemical than the liquid will carry in solution; this resulting solution is filtered to remove the excess chemical and then used as a base. For example, to make a 10 per cent solution, 10 per cent of the base is used and 90 per cent of the pure liquid, or in other words, 1 ounce of the saturated solution to 9 ounces of the liquid.

Contributed by ALBERT W. WILSDON.

TO PETRIFY WOOD.

Equal quantities of gem salt, rock alum, white vinegar, chalk and Peebles' powder. This solution will petrify wood or any other porous substances if put in after the ebullition is over.

A Stone Coating for Wood: Forty parts chalk, fifty of resin, four of linseed oil, melted together; to this should be added one part of oxid of copper and then one part of sulfuric acid. This last should be added very carefully. Apply with a brush while hot.

To Imitate Dark Woods: The appearance of walnut may be given to white woods by painting or sponging with a concentrated warm solution of permanganat of potassium. The effect varies for different kinds of woods, some becoming stained rapidly, others requiring more time. When stained wash thoroly with soft water. After the wood has dried it may be varnished, and will be found to very closely resemble the natural dark woods.

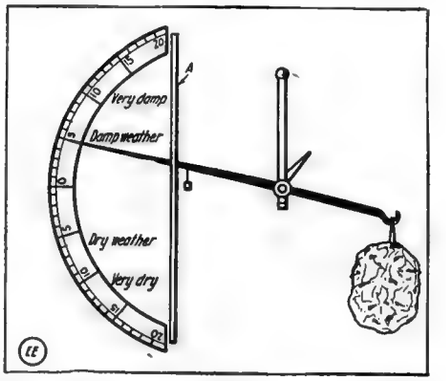
To Polish Wood: Only a very few experimenters who make their own cabinets know how to put a good polish on their woodwork. The following is a very good method. Take a piece of pumice stone and water, and pass regularly over the work until the rising of the grain is cut down; then take tripoli and boiled linseed oil, and polish to a bright surface.

Contributed by V. C. McILVAINE.

HOW TO MAKE A HYGROMETER.

The hygrometer is an instrument to measure the degrees of dryness or moisture of the atmosphere. There are various kinds of hygrometers; for whatever body either shrinks or swells by dryness or moisture, is capable of being formed into an hygrometer, such as woods of most kinds, particularly ash, deal, poplar, etc. The following is the most lasting and convenient mode of construction for an instrument of this description.

Take a very fine balance, and place in it a sponge, or other body which easily absorbs moisture, and let it be in equilibrium with a weight hung at the other end



A Simple Hygrometer Which Can Be Made at a Cost of a Few Cents, from a Sponge, a Paper Scale and a Lightly Pivoted Lever.

of the beam. If the air becomes moist, the sponge, becoming heavier, will preponderate; if dry, the sponge will be raised up. This balance may be contrived in two ways, by either having the pin in the middle of the beam, with a slender tongue, a foot and a half long, pointing to the divisions of an arched plate, fitted on it, or the other extremity of the beam may be so long, as to describe a large arc on a board placed for the purpose.

To prepare the sponge, it may be necessary to wash it in water and, when dry, in water or vinegar, in which sal ammoniac or salt of tartar has been dissolved and let it dry again; then it is fit for use. The instrument can be hung against the wall; and, in that case a bit of steel, as at "A," should be placed before the needle, to keep it straight.

Contributed by WILL M. DUFFIE.

COLD SOFT SOLDER.

Everyone at sometime or other has had occasion to solder two pieces of metal, which because of their composition, or because of attached parts, could not be raised to the temperature that even soft solder flows at. The following solder meets that demand, as it can be used without heat.

Precipitate some copper from a copper solution, such as copper sulfate or copper nitrat by means of zinc or iron filings. Into a mortar pour some mercury and the copper precipitate. Add a few drops of dilute sulfuric acid and grind until the copper has united with the mercury. Wash the amalgam with water till bright and clean. Put into a cloth to dry and by means of a twisting motion, like grapes are strained, squeeze out the excess of mercury until the copper amalgam is just workable by the fingers. Rub well into the surfaces to be joined, and press together over night. Some of the mercury penetrates the surfaces, and some of the copper crystallizes out, and the compound becomes very hard. Strange to say, this compound is silver white. By using more mercury, a pliable metal is obtained that hardens slowly. If the solder is too hard, grind up with more mercury. Keep gold and silver jewelry, etc., out of the way, as mercury destroys them.

Contributed by H. V. PFEIFFER.

WITH THE AMATEURS

Our Amateur Laboratory Contest is open to all readers, whether subscribers or not. The photos are judged for best arrangement and efficiency of the apparatus. To increase the interest of this department we make it a rule not to publish photos of apparatus unaccompanied by that of the owner. Dark photos preferred to light toned ones. We pay each month **$3.00** prize for the best photo. Make your description brief and use only one side of the sheet. Address the Editor, "With the Amateurs" Dept.

$15.00 Cash in Prizes. Get Busy, Boys!!!

Here is your chance to win a cash prize for a few minutes' brain work. The big question now confronting every radio amateur is—"What can I do with my wireless apparatus?" To help the more than 400,000 loyal radio students and enthusiasts to apply their knowledge and, most important of all, to utilize their instruments for some practical electrical or communication purpose **other than wireless,** we shall pay two prizes—one of $10.00 and one of $5.00 respectively, for the best suggestion as to "what to do with your radio set during the war." Be brief; 100 to 200 words should tell your story, Remember—it's the "idea" that counts. Get busy at once, boys, as we want all suggestions in by July 25th, at the latest, so that the results can be announced in the September number of THE ELECTRICAL EXPERIMENTER. And don't forget we must have thoroly "practical" ideas. Address the Editor, Radio Problem Contest.

A GROUP OF REPRESENTATIVE AMERICAN AMATEUR RADIO STATIONS.

$3.00 Prize This Month Awarded to Amateur Radio Station of 8—Parker Wiggin, Kansas City, Kan. 1—William P. Aldrich, Westfield, Mass.; 2—Radio station of Orney Dunnum, Hannaford, N. D.; 3—N. W. Lockwood, East Orange, N. J.; 4—Lucas Tylekens, Jr., Kansas City, Mo.; 5—Walter Reimer, Milwaukee, Wis.; 6—Lester S. Fawcett, Independence, Iowa; 7—Ole B. Ritchey, Lake City, Mich.; 9—Lovell H. Cook, Mexico, N. Y.; 10—Henry W. Hall, Beeville, Tex.; 11—Otto Vandell, Brooklyn, N. Y.; 12—Hubert F. Jordan, Evanston, Ill.; 13—Palmer Reist, Dayton, O.

Some More Representative American Amateur Radio Stations.

ALL RADIO AMATEURS ATTENTION!

As all of you know the United States is now in a state of war with Germany, and as true-blood American citizens, we are, each and every one of us, duty bound to obey the mandates of the U. S. Government officials. The Navy Department has been delegated by our President to close all amateur or experimental radio stations, no matter whether equipt for transmitting or receiving, licensed or unlicensed, and therefore we shall all have to abide by this decree, whether we like it or not.

Therefore, beginning with the next issue of "THE ELECTRICAL EXPERIMENTER," we will endeavor to feature the Electrical Laboratories in preference to any radio stations in the awarding of the monthly prize of $3.00 in this department. Now is the time to get busy and freshen up your electrical apparatus, and incidentally improve your understanding of electrical matters, which perhaps you have unwittingly slighted to a large degree in your pursuit of radio-telegraphy. Let her go, boys!

14—Radio Station of Louis Falconi, Fort Stanton, N. Mex.; 15—Lessesne R. Allison, Statesville, N. C.; 16—Frank O. Walsh, Jr., Augusta, Ga.; 17—Geo. Anderson, Dorchester, Mass.; 18—James B. Armstrong, Ithaca, N. Y.; 19—L. C. Herndon, Portsmouth, Va.; 20—Allen B. Du Mont, Montclair, N. J.; 21—Morris Pollack, Chicago, Ill.; 22—H. Muyskins, Jr., Lynden, Wash.; 23—Geo. M. Bends, Utica, N. Y.; 24—Earl McClure, Van Wert, O.; 25—Butswick Brattland, Ada, Minn.; 26—Geo. E. Meldrum, Jr., Carrollton, Ill.; 27—Clyde R. Battin, Athens, Ohio.

THE MARVELS OF RADIO-ACTIVITY.

(*Continued from page* 171)

of the leaves being indicative of the amount of Radium in a certain amount of sample.

Rutherford showed that the discharging effect is due to the production of *ions* or *charged particles* of the gas thru which the radiations pass. In an electric field, positive ions travel to the negative electrode and vice versa; thus causing the discharge of an electrified body. If a sufficiently strong field is used, the ions are all swept to the electrodes without appreciable loss. The rate of discharge then reaches a maximum, which is not altered by an increased voltage, this maximum current being called the saturation current. The ions produced are in every way identical with those produced by X-rays. This phenomenon of *ionization* is the basis for the conductivity of gases caused by radioactive substances.

Radium

Radium has been definitely determined as an element, atomic weight 226.2 (Mme. Curie). It imparts a brilliant red color to a flame and red predominates in its flame spectrum. The production of Radium is in this country largely from the ore carnotite, an Uranium oxid, found in Colorado and Utah. The Radium is extracted by chemical means from the ore together with Barium, from which it is separated by fractional crystallization. The bromid salt of Radium is slightly less soluble than that of Barium, so on cooling a solution, crystals richer in Radium than in Barium separate out first. After six or eight successive operations, pure crystals of Radium bromid are obtained, which are then ready for the market.

The prominence attained by Radium is due more to its ease of production and the amount of easily secured ore than to any exceptional properties it possesses over many of the other radioactive elements.

Besides the radiations given off by Radium, there is produced in addition a gas, known as "emanation." This gas is about a hundred thousand times as active as Radium itself. When introduced into a glass tube it causes a bright glow. This glow increases to a brilliant illumination when substances which phosphoresce, as zinc sulfid, are put into a tube containing emanation. Fig. 2.

By means of this emanation a finer estimation of amounts of Radium than by the ordinary electroscopic method can be made. The emanation is driven off by boiling and conducted into a suitable electroscope and the rate of collapsing of the leaves noted as compared to a standard. Quantities of radium as small as .000,000,000,001 gram can be detected and determined. This emanation method is used to determine the amount of Radium in rocks and minerals.

Another method for quantitative measurements of small amounts of Radium, when not less than 1/100 of a milligram is present, is to place the tube containing the Radium some distance from a lead screen and measure the rate of discharge of an electroscope, as compared with the rate caused by a standard amount of radium similarly placed. The material being investigated must be at least a month old, in order that the emanation be in equilibrium with the Radium (due to decay and recovery, as explained later). This method is simple and direct, as the tube need not be opened nor the material weighed.

The radioactive substance, Actinium, also gives off an emanation, whose activity dies in a few seconds. Polonium likewise undergoes a series of changes, there being considerable evidence that the final product is *lead*. Polonium is much more active than Radium, but occurs in smaller quantities. Marckwald obtained three milligrams from fifteen tons of pitchblende residue. The amount of Polonium in a Radium mineral is 1/5000 of the amount of the Radium.

Another body, known as "Ionium," has been recently separated with similar radioactive properties. Ionium compounds are several thousand times as active as those of Uranium. The especial interest in Ionium is that its decomposition product is Radium, altho its period of transformation is much longer than that of Radium.

It has been found that Uranium, Ionium, Radium, Actinium, Thorium—all break down, some giving off emanation, into new substances which in turn break down again into others, and so on thru the series. This phenomenon is nothing more or less than a spontaneous commutation of matter.

Perhaps the ancient Alchemists' ideas were not entirely wrong!

(*To Be Continued*)

NIKOLA TESLA RECEIVES THE "EDISON MEDAL."

Nikola Tesla, the famous electrical wizard, who was awarded the seventh Edison medal on December 13, 1916, "for meritorious achievements in his early original work in polyphase and high-frequency electric currents," received the medal at a presentation made at the annual meeting of the American Institute of Electrical Engineers, on May 18.

The Edison Medal was established upon the initiative of a group of friends and associates of Thomas A. Edison, for the purpose of recounting and celebrating the achievements of a quarter of a century in the art of electric lighting, with which the name of Edison is imperishably identified. It was decided that the most effective means of accomplishing this object would be by the establishment of a gold medal, which should, during the centuries to come, serve as an honorable incentive to scientists, engineers and artisans to maintain by their works a high standard of accomplishment.

The Edison Medal was, therefore, established and endowed with a trust fund, under an indenture dated February 11, 1904, whereby the American Institute of Electrical Engineers agreed to award the medal annually. It is awarded each year by a committee consisting of 24 members of the Institute to a resident of the United States of America and its dependencies, or of the Dominion of Canada, "for meritorious achievement in electrical science or electrical engineering or the electrical arts."

B. A. Behrend said:—

"By an extraordinary coincidence, it is exactly twenty-nine years ago, to the very day and hour, that there stood before this Institute Nikola Tesla, and he read a description of his great discovery of the generation and utilization of polyphase alternating currents. He left nothing to be done for those who followed him. His paper contained the skeleton even of the mathematical theory.

"Three years later, in 1891, there was given the first great demonstration, by Swiss engineers, of the transmission of power at 30,000 volts from Lauffen to Frankfort by means of Mr. Tesla's system. A few years later this was followed by the development of the Cataract Construction Company, under the presidency of our member, Edward D. Adams, and with the aid of the engineers of the Westinghouse Company. It is interesting to recall here to-night that in Lord Kelvin's report to Mr. Adams, Lord Kelvin recommended the use of direct current for the development of power at Niagara Falls and for its transmission to Buffalo.

Nikola Tesla, Prince of Electrical Inventors, Who Was Recently Awarded the "Edison Medal."

"The basis for the theory of the operating characteristics of Mr. Tesla's rotating-field induction motor, so necessary to its practical development, was laid by the brilliant French savant Prof. André Blondel, and by Professor Kapp of Birmingham. It fell to my lot to complete their work and to co-ordinate—by means of the simple 'circle diagram'—the somewhat mysterious and complex experimental phenomena. As this was done twenty-one years ago, it is particularly pleasing to me, upon the coming of age of this now universally accepted theory—tried out by application to several million horse-power of machines operating in our great industries—to pay my tribute to the inventor of the motor and the system which have made possible the electric transmission of energy. His name marks an epoch in the advance of electrical science. From that work has sprung a revolution in the electrical art."

ELECTRIC RESISTANCE OF SELENIUM CELLS.

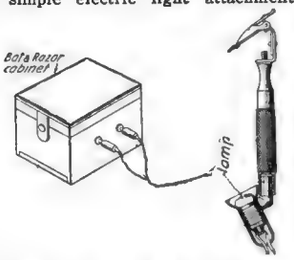
According to Professor H. Greinacher of Zurich, selenium cells of the original Shalford Bidwell type, which he studied together with Mr. C. W. Miller, behave with respect to alternating currents as they behave when exposed to light, and show polarity when traversed by continuous currents. Communicating his observations to the German Physical Society, Greinacher stated that the resistance of the selenium cell rose when direct current flowed in the dark, that this increase in resistance was different for positive and for negative currents and increased with the time, and that selenium cells acted in a certain sense like current rectifiers. These statements are questioned by Dr. Robert Furstenau of Berlin, who, in experimenting with hundreds of selenium cells with similar bridge arrangements as Greinacher, had never noticed any of these effects. Furstenau suggests that Greinacher's cells had been of peculiar kind. That selenium cells are very sensitive to moisture, and that the electrode material may have peculiar puzzling effects, is fairly well understood, and these features may explain some of the controversial statements made from time to time.

LATEST PATENTS

Electric Light for Razors

(No. 1,223,305; issued to Katherine E. Allport.)

At last an inventor has come to the rescue of the long-suffering bath-room barber and here provides a simple electric light attachment

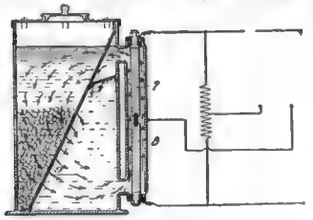


so that one may see at all times on any part of the face, which is usually difficult with the ordinary source of illumination, due to shadows. She also provides a neat combined razor and battery cabinet, the lower part containing a suitable dry battery, with a flexible cord to connect the miniature lamp with the battery. A new battery may be quickly placed in the cabinet by means of a sliding bottom. The device would seem of extreme value to all military and traveling men.

The Electrolytic Rectifier

(No. 1,223,114; issued to Charles C. Ruprecht.)

An improvement in the design of electrolytic rectifiers which conduces to the thoro circulation of the electrolyte solution, as the ar-

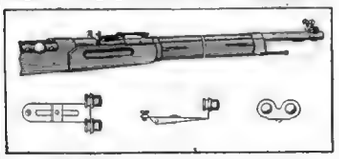


rows in diagram illustrate. The metal electrodes 7 and 8 are placed in a small chamber which communicates with the main circulating chamber thru two ports, the solution continually rising, due to heating, and passing thru the salts deposited in the lower part of the pocket formed by diagonal grid as indicated. The inventor claims that the solution will thus be kept saturated at all times and that heating is reduced to a minimum, with increased efficiency in consequence.

Night-Sight for Firearms

(No. 1,225,592; issued to Britannio Solaro.)

A clever invention of particular value at this time and involving the use of special back and fore-sights for rifles or other firearms, each sight being provided with chambers

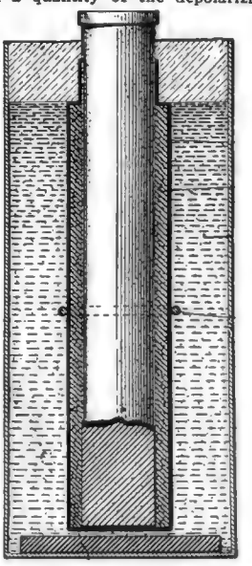


or cavities enclosed by a lens, and adapted to contain a salt of radium which will emit rays of light, these being concentrated as a spot of light by the lens in each case. When the back-sight and fore-sight are applied to a rifle, as shown, it becomes evident that the ordinary sights of the rifle will not be obstructed.

Galvanic Cell

(No. 1,221,062; issued to Morduch L. Kaplan.)

New design of miniature dry cell as used particularly for flash-lights. Use is made in this cell of a higher oxid of manganese, which apparently consists of manganese in two or more stages of oxidation, and in a peculiar form whereby extremely satisfactory depolarizing action is secured, and whereby it becomes possible to concentrate and compact finely-divided grafite or other suitable form of conducting carbon with such a quantity of the depolarizing

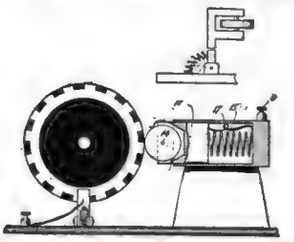


compound that long life of the cell is assured. The inventor has found that a lower oxid is desirable in combination with the higher oxid, to assure a novel and pronounced depolarizing action. He claims by this means a certain measure of transference of oxygen from the interior to the exterior of the cell, so that depolarizing efficiency does not depend merely on surface exposure, but also on the gross amount of the manganese compound.

Electric Interrupter

(No. 1,224,570; issued to Stuart Sandreuter.)

An electric interrupter intended

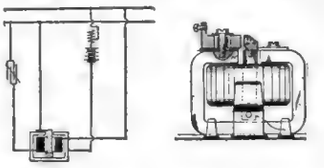


for low frequencies and comprising an insulating disc which carries a ring of conductive material provided with a plurality of radial extensions between which are mounted insulating strips or segments. The disc shaft may be driven by a motor or other device in order to rapidly rotate the same. Contact with the rapidly rotating segmented metal ring is effected thru a spring actuated rolling wheel. Connection is made with the segmented perifery of the rotating disc by means of a suitably proportioned metal wheel 14. This is pivoted in a sliding metal block 11, constantly pushed forward by a spiral spring 15, and connected with binding post 10 by flexible conductor 17.

Alternating Current Rectifier

(No. 1,221,981; issued to Thomas A. Edison.)

A simplified form of vibrating rectifier for charging storage batteries, etc. It involves a permanent

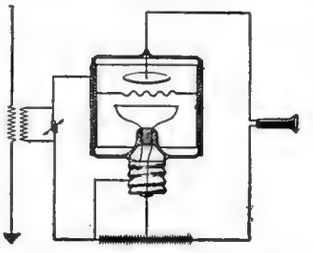


steel polarizing magnet, a set of vibrating reeds and an actuating magnet coil. The contacts on the vibrators and fixt electrodes are of special carbon to cut down arcing and sticking of contacts. By connecting the rectifying contacts in parallel a large current capacity is obtained; in series a relatively high potential current can be handled. The amplitude of movement of the vibratory contacts is small—about 10 thousandths of an inch.

Ionized-Chamber Device

(No. 1,222,916; issued to Clifford Dudley Babcock.)

A clever arrangement for ionized-chamber detectors or amplifiers of the de Forest type, and here shown in a de Forest radio receiving circuit. The inventor simplifies the construction and gains the advantage of having a finely adjustable variable condenser incorporated in the device itself, by means of two

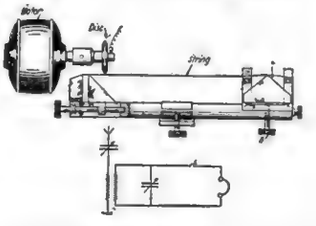


metal sleeves placed inside and outside of the tubular glass bulb. The inner sleeve supports the usual grid and is charged thru the glass dielectric from the outer sliding metal sleeve, connected in the circuit as shown.

Undamped Wave Receiver

(No. 1,224,343; issued to James O. Watkins.)

The "tikker" apparatus comprises a suitable base and upright members of small size, and which serve to support adjustably a metal wire or string. The tension of this string is adjustable by raising or lowering

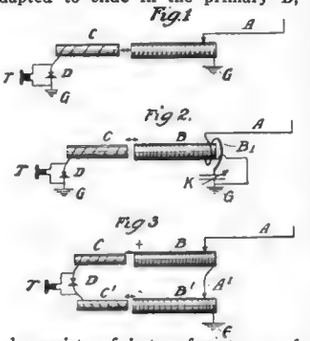


a pointed tension block A, by means of thumb screw B. The string is vibrated at radio frequency by means of a smooth-edged disc mounted on the shaft of a motor.

Radio-Telegraph Receptor

(No. 1,224,499; issued to Greenleaf Whittier Pickard.)

An improved method of receiving radio-telegraphic or telephonic signals wherein (Fig. 1) the secondary coil C has only one side connected to the receiving apparatus D-T, which may be grounded. Fig. 2 shows a like arrangement except that the coupling between aerial A and primary B is made inductively. Fig. 3 is similar to Fig. 1, except that two primaries B and B1 are used. T may be a telephone receiver, and D a crystal rectifying detector. Coil B is of sufficient length to cause its natural period to be equal to the shortest desired wave length. The secondary C, is adapted to slide in the primary B,

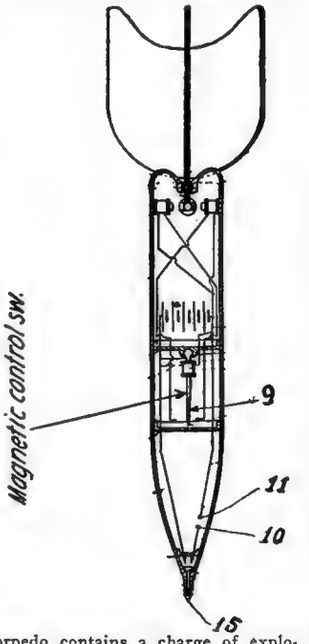


and consists of but a few turns of coarse wire having a natural period much smaller than the shortest desired wave length.

Aerial Torpedo Steering Device

(No. 1,222,630; issued to Lemuel John Husted.)

A unique idea involving the use of "magnetic attraction" to actuate a special rudder control switch so as to cause an aerial torpedo or similar projectile to unfailingly reach its target when the latter is composed of a steel or iron shell structure. The lower part of the



torpedo contains a charge of explosives to be detonated by an electric fuse 10-11, operated by switch 15, when the missile strikes its target.

The inventor provides an "attraction" electro-magnet 9, suspended to swing in any direction.

Phoney Patent Offizz

Under this heading are publisht electrical or mechanical ideas which our clever inventors, for reasons best known to themselves, have as yet not patented. We furthermore call attention to our celebrated Phoney Patent Offizz for the relief of all suffering daffy inventors in this country as well as for the entire universe.

We are revolutionizing the Patent business and OFFER YOU THREE DOLLARS! $3.00 FOR THE BEST PATENT. If you take your Phoney Patent to Washington, they charge you $20.00 for the initial fee and then you haven't a smell of the Patent yet. After they have allowed the Patent, you must pay another $20.00 as a final fee. That's $40.00 ! ! WE PAY YOU $3.00 and grant you a Phoney Patent in the bargain, so you save $43.00 ! ! When sending in your Phoney Patent application, be sure that it is as daffy as a lovesick bat. The daffier, the better. Simple sketches and a short description will help our staff of Phoney Patent examiners to issue a Phoney Patent on your invention in a jiffy.

No. $\left(\frac{\text{M. I. L. K.}^{\circ}}{H_2O}\right)$

Lapup Cowjuce of Milkshake, N. D.

Patent Appraised

CUDOMOTOR

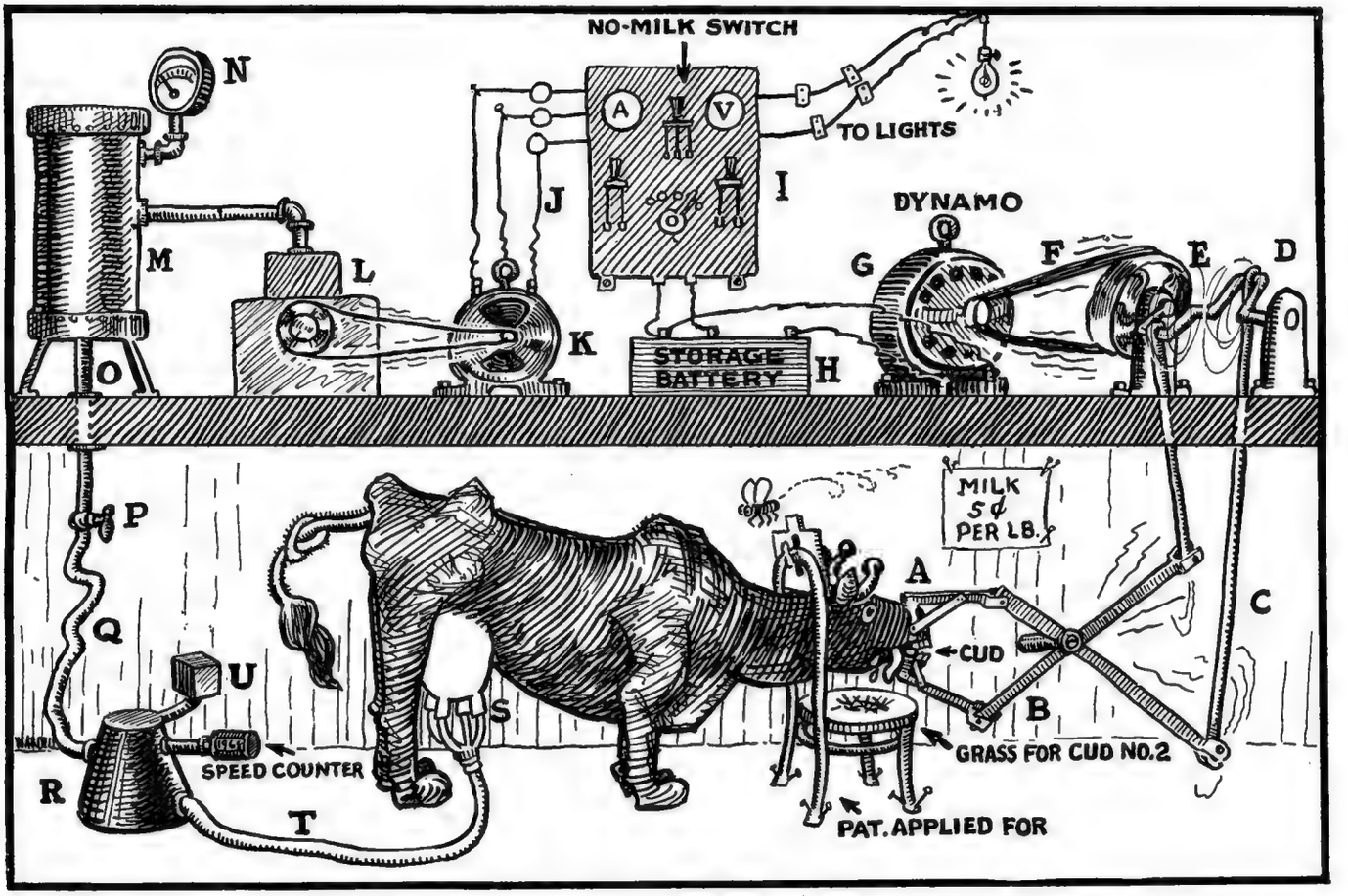
To Whome It May Constern:

Be it appraised to all cows, calves, dairymen, dairymaids, dairyouths, dairywomens, and all others interested in the lacto industry, that I, Lapup Cowjuce of the City of Milkshake, in the State of Nervous Depression, have at the risk of my decaying sanity, invented and designed a world-upheaving device, whereby it is made possible at last for cows to milk themselves, automatically without cost or expense.

As is universally known among cows and dairypeople, cows continually "chew their cud." Here we have a constant form of energy, which has been calculated to represent about 9¾ cow-power per day. It has also been calculated that the cow to chew the cud efficiently only requires 5¾ cow-power. This leaves a net wastage of 4 C.P. per day. This totally wasted energy I have now at last harnest, in as simple as it is efficient manner. Not only do I use this energy to milk the cow itself, but I use it also to light the house, run the butterchurner as well as the buttermilker.

First the cow is secured properly to a simple mechanism to keep her from backing away (patent applied for). To her jaws are now attached jaw clamps A. These in turn are attached to a scissor-mechanism B, pivoted on silk ball-bearings as shown. It becomes apparent that as the cow chews, the scissor mechanism is given a reciprocating movement. This motion is transmitted thru lateral zinc rods C, connected in turn to brass cranks D. By means of soft rubber pulley E, the wooden belt F now transmits the resulting energy to the selenium pulley of Dynamo G. This latter on account of the oscillatory moving jaws of the cow, generates an oscillating alternating current, which then charges the alternating current storage battery H. This resulting current oscillates thru the Tungsten switchboard I, and thence thru the connecting platinum cables J. The current then drives the bashful motor K which now operates the anaemic hot-air compressor L. The resulting comprest and perfumed air is then stored free of charge in the leather tank M. Hot wire ammeter N is used to observe too high a temperature. The air is now conveyed thru glass pipe O, thru Galena stop-cock P, thence thru flexible cast iron supply pipe Q. Galena is used on the stop-cock because it is very sensitive. The oscillating air next flirts into the quartz pulsator U, from which it escapes to liberty. This creates a pulsating vacuum in the scanatory Bakelite milk can R. But as the latter is connected by means of a flexible hard-rubber tube T, to the cow's teats, by means of teat-cups (not tea-cups) it follows that the milk is drawn rapidly into the can R.

What I claim is:



". . .I, Lapup Cowjuce of the City of Milkshake, N. D., Have at the Risk of My Decaying Sanity, Invented and Designed a World-Upheaving Device, Whereby It Is Made Possible At Last for Cows to Milk Themselves Automatically By the Surplus 'Cow-Power' Developed By Their Constant Cud-Chewing."

1st—An automatic cow-milk dispenser, dispensing with all milkmaids.

2nd—A cow-milker operated by the cow's own cud-chewing.

3rd—A motor attachable on all ruminators and other rummies.

In memoriam henceforth and hencewith I have therefore caused and by these presents do hereby depose upon this legal instrument my south-western uppermost backhoof, this 3rd day of our Grace, in the 149th year of the French Revolution.

Fitnesses: LAPUP COWJUCE,
A. Heluvaguy, *By his attorney:*
A. W. Dryup, LEONARD SARVER,
S. O. Mecrust. Enid, Okla

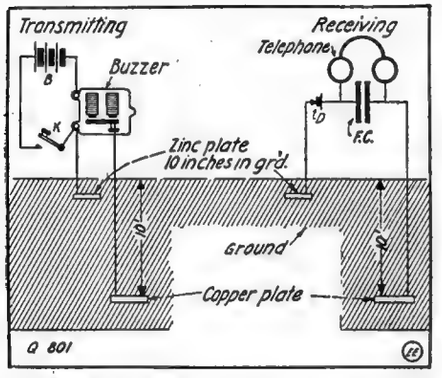
This department is for the sole benefit of all electrical experimenters. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be publisht. Rules under which questions will be answered:

1. Only three questions can be submitted to be answered.
2. Only one side of sheet to be written on; matter must be typewritten or else written in ink; no penciled matter considered.
3. Sketches, diagrams, etc., **must** be on separate sheets. Questions address to this department cannot be answered by mail free of charge.
4. If a quick answer is desired by mail, a nominal charge of **25 cents** is made for each question. If the question entail considerable research work or intricate calculations a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.

BUZZER TELEGRAPH SYSTEM.

(801.) O. M. Warren, Detroit, Mich., asks:

Q. 1. Would it be possible to use the following scheme to telegraph a distance of a block or two?



An Effective "Buzzer" Telegraph System Which Employs Two "Ground" Plates at Each Station, Each Plate Buried at a Different Level. A Radio Detector, Fixt Condenser and Telephone Receiver Are Used at the Receiving Station.

A. 1. Yes. You will have no trouble in transmitting considerably more than the distance you mention.

Q. 2. If possible would a tuning coil or loose coupler connected in the receiving circuit improve it?

A. 2. A tuning coil or loose coupler should not be used with this system, as it is impossible to tune any distant signal with this ground telegraph system, speaking generally.

ADHESION PHENOMENON.

(802.) Betram Wertheim, N. Y., writes us:

Q. 1. Whenever, after typing carbon copies, I find that a strange phenomenon occurs. The papers, including the carbons, are charged with static electricity and they all adhere to each other. The most peculiar thing about this phenomenon is that all the papers seem neither to be charged negatively or positively, but neutrally. No matter how I change their positions to each other, they always attract. I therefore come to the conclusion that they must be charged neutrally, or by some new form of static electricity.

A. 1. The peculiar phenomenon which you have observed with the paper sheets is due directly to the adhesion properties of air when it comes in contact with paper and when the papers are separated, they stick to each other. A similar experiment can be demonstrated by placing a sheet of paper on a flat table and quickly lifting it up; you will observe that the paper will tend to stick to the table. This is due to the adhesion properties of air; also a partial vacuum is usually created. There is nothing electric about it.

OXYBENZYLMETHYLENGLYCOLANHYDRIDE.

(803.) Harold Betts, Sacramento, Cal., wishes to know:

Q. 1. What is the chemical symbol for "Oxybenzylmethylenglycolanhydride" (Bakelite)?

A. 1. At the present time there is no chemical symbol to the Bakelite as the chemical decomposition of phenol, which is the ingredient used in the making of this compound is still a puzzle to the modern chemist. It is one of the most difficult problems of the chemist to obtain the symbol of an organic compound, and Bakelite is one of these.

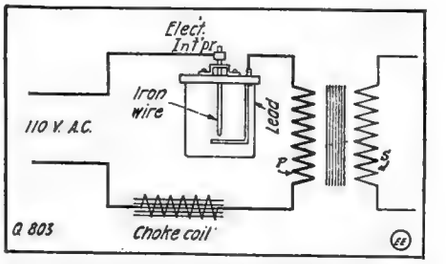
Q. 2. Which is the best, an aerial of two wires fifty feet long, or an aerial of one wire one hundred feet long? Why?

A. 2. As to whether the antenna is to be used for receiving or transmitting, the two wires 50 feet long are better for the latter purpose, as the antenna must have as much capacity as possible in order to obtain the maximum efficiency therefrom, and when combining the two conductors, the capacity is increased. A single wire 100 feet long is desirable for receiving purposes, as the capacity of such antenna is uniformly distributed and at the same time the inductance is increased, which permits finer tuning of received signals.

Q. 3. Is it possible to make an electrolytic interrupter for a spark coil operating on 110 volts A. C., and if so, how?

A. 3. Yes. An electrolytic interrupter for this purpose can be made by placing a lead electrode in a container and adding a solution composed of one part of sulfuric acid and nine parts of water. A second electrode, made of small diameter iron wire is placed perpendicularly to the first electrode, as shown, taking care that they do not touch each other. It is preferable to enclose the iron wire or electrode of smaller surface within a porcelain tube having a small orifice at the lower end, which will just pass the wire. With the iron wire relatively very small as compared to the surface of the lead electrode, and with the applied potential and current critically adjusted, as well as the inductance and capacity of the circuit properly balanced, an interruption action can be effected.

The interrupter is then connected in the usual way and the wiring diagram herewith gives the proper connections. The choke coil which is connected in the primary circuit should consist of an iron wire core one inch in diameter and 12 inches long. Two layers of No. 14 D.C.C.-magnet wire are wound on it. This coil should invariably be used, as considerable trouble is encountered in running electrolytic interrupters on alternating current.



Simple Electrolytic Interrupter for Use on Alternating Current Circuits with Spark Coils or Open Core Transformers.

AUDION CIRCUIT QUERY.

(804.) Oscar F. Miller, Milwaukee, Wis., says:

Q. 1. I have a receiving apparatus composed of the following:—Audion detector, 4,500 meter loose coupler, 6 volt—60 amp. hour storage battery, Brandes' 'phones, an aerial 150 ft. long, 4 wires, which gave very poor results. The Audion (de Forest tubular type) has been tested and is O.K. I am sending a diagram of my set. Kindly advise me what you think my trouble is.

A. 1. The trouble is with your wiring

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As to what to photograph: Well that's hard for us to say. We leave that up to you, and every reader now has the opportunity to become a reporter of the latest things in the realm of Electricity, Radio and Science. But, please remember—it's the "odd, novel or practical stunts" that we are interested in. Every photo submitted should be accompanied by a brief description of 100 *to* 150 *words. Give the "facts"—don't worry about the style. We'll attend to that. Enclose stamps if photos are to be returned and place a piece of cardboard in the envelope with them to prevent mutilation. Look around your town and see what you can find that's interesting.*

To give some idea of the freak photos we like—refer to page 188.

Address photos to—Editor "Odd Photos," ELECTRICAL EXPERIMENTER, *233 Fulton Street, New York City.*

diagram, and the only way to remedy it is to connect the filament terminal with one leg of the secondary of the coupler, and disconnecting the "B" battery terminal with the leg of the secondary, as you have it at present.

BOOKS.

(805.) H. H. Bales, Halifax, N. F., wants:

Q. 1. The prices of the following text books: "Alternating Current Electricity and Its Applications to Industry"—By W. H. Timbie and H. H. Higbie, 729 pages, Second Course, 1916. Also "Practical Electricity." Latest edition, published by the Cleveland Armature Works.

A. 1. The price of "Alternating Current Electricity and Its Applications to Industry," is $3.00, and "Practical Electricity" is worth $2.00. These books, as well as any others, can be obtained thru our "Book Department," by sending amounts stated.

TELEPHONE MAGNETS.

(806.) A Reader, Otsego, Michigan, wishes to know:

Q. 1. How can I magnetize telephone magneto magnets?

A. 1. The magneto magnets can be re-magnetized by employing an electro-magnet consisting of two poles; the distance between these poles should correspond to the distance between the magneto magnet poles. By passing a current thru the electro-magnet and holding the same against the poles of the steel magneto magnet, so as to permit the magnetism to flow into the poles of the permanent magnet, the latter will be revitalized. The N. pole of the electro-magnet should be placed against the S. pole of the magneto-magnet.

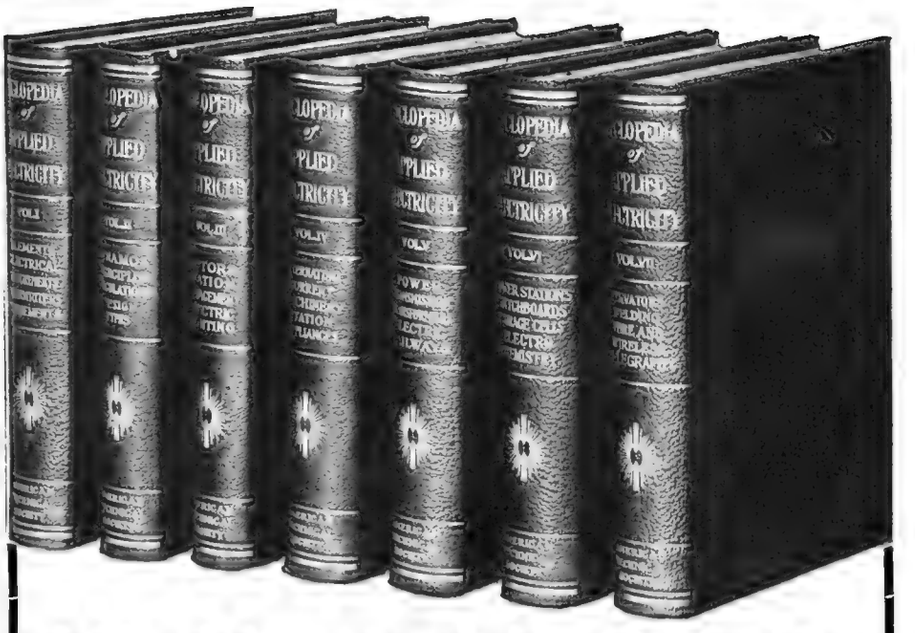
Q. 2. What is the approximate voltage of my telephone magneto and also the amperage? It is a two-bar double magnet type.

A. 2. It is impossible for us to give you the voltage and amperage developed by your magneto, as the required data such as speed of armature, number of conductors on the armature and the flux density is not given; we are thus unable to answer your query and if you will enlighten us on the above-mentioned points, we will be pleased to help you out in this respect. Telephone magnetos as a rule develop between 200 and 300 volts A. C. The amperage is about 1/10 to 1/8.

Q. 3. My radio receiving set consists of a twenty-seven hundred meter tuner, single slide, and a six-hundred meter tuner used as *loader*. I have a silicon detector, fixt condenser and 1,000 ohm receiver. My aerial was a "T" type and comprised a single "Antenium" wire with lead-in 75 ft. long. Ground of iron pipe driven into hard clay. I never heard anything but static; can you tell me what the cause of this is? I have never heard a signal. If it is some minor trouble and if I remedied it, could I receive Arlington and N.A.R. (Key West), with it?

A. 3. The trouble is undoubtedly with your *ground*, and this can be remedied by placing a copper sheet about 6 feet square in the ground. This should be placed 10, or even 15 feet deep, in the earth, covering the same with pulverized charcoal and impregnating the total mass with salt water, which will improve the ground conductivity considerably.

In regard to the reception of Arlington time signals with your present equipment, we are very much in doubt as to whether it can be done, but by the employment of an Audion detector, a variable condenser shunted across the secondary of the inductive coupler and a pair of 2,000 ohm 'phones, you should have no trouble



All About Electricity

Anything you want to know about electricity can be found in these seven thick volumes. Every line is written in plain language—language that everyone can understand. The 1916 edition—**just off the press**—covers the generation and use of electricity for power, light, transportation and communication, including the construction and operation of dynamos and motors. Also covers central station engineering and telephone work, as well as **wireless telegraphy and telephony** and land and submarine telegraphy. Valuable alike to the electrical experimenter, experienced electrician and electrical engineer.

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Cyclopedia of Applied Electricity

Contains 3,200 pages, 7x10 inches; 3,000 illustrations, full page plates, diagrams, etc.; hundreds of valuable tables and formulas; carefully cross-indexed for quick, easy reference. The books are substantially bound in half red morocco, gold stamped, and are printed in large, clear type on special quality paper.

What These Books Cover

Elements of Electricity—Electrical Measurements—Underwriter's Electrical Requirements—Theory, Calculation, Design and Construction of Direct Current Generators and Motors—Types of Generators and Motors—Management of Electrical Machinery—Electric Lighting—Alternating Current Machinery—Power Transmission—Electric Railways—Self-Propelled Railway Cars—Trackless Trolleys—Power Stations—Switchboards and Switching—Storage Batteries—Applied Electrochemistry—Electric Elevators—Electric Welding and Heating—Wireless Telegraphy and Telephony—Land and Submarine Telegraphy.

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NAME .....

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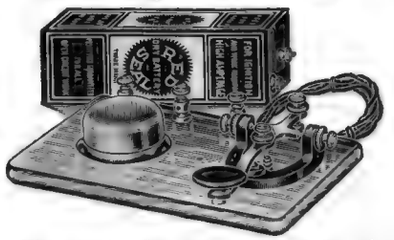
Mesco Wireless Practice Set

For Learning the Wireless Code



The Practice Set comprises a regular telegraph key, without circuit breaker, a special high pitch buzzer, one cell Red Seal Dry Battery, and four feet of green silk covered flexible cord.

The key and buzzer are mounted on a highly finished wood base, and three nickel plated binding posts are so connected that the set may be used for five different purposes, as illustrated on page 24.

For the beginner, the set is of exceptional value, for it may be used for individual code practice or for operation of a two party line, which is an excellent method of quickly learning the code. After the beginner has mastered the code, the set may be used in his wireless outfit for setting the detector in adjustment, and also the key may be used to control the spark coil.

Recommended for schools, as it gives excellent service for class instruction in code work. Full directions with each set.

The main object of the set is to enable the beginner to master the wireless code, and the buzzer reproduces the sound of the signals of the most modern wireless stations perfectly.

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in receiving Arlington or N.A.R. But bear in mind that during the war, no wireless outfits can be operated by anyone.

WIRELESS TELEPHONE CONNECTION.

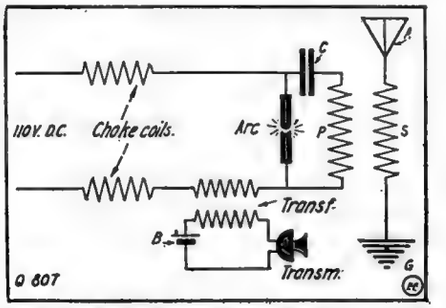
(807.) Ivan Bulock, Fairmont, Minn., writes:

Q. 1. Which is the best way to connect an ordinary carbon grain transmitter on 110-volt., 6 amp. d.c., for wireless telephony?

A. 1. The accompanying wiring diagram shows the best way of connecting such a transmitter.

Q. 2. Could an ordinary one-inch spark coil be used as a transformer for wireless telephony?

A. 2. No. The current obtained from the secondary of a one-inch spark coil is so small that it does not warrant its use.



Hook-Up for Wireless Telephone Arc Circuit with Microphone Inductively Connected to Control Oscillations.

WHAT IS SYNCHRONISM?

(809.) H. Somerfelt, Butte, Mont., asks:

Q. 1. What is meant by synchronism?

A. 1. This term may be defined as the simultaneous occurrence of any two events. Thus two alternating currents are said to be in synchronism when they have the same frequency and are in phase.

Q. 2. For what service are the 25-cycle and 60-cycle currents adapted?

A. 2. The 25-cycle frequency is used for conversion to direct currents, for alternating current railways, and for machines of large size; the 60-cycle frequency is used for general distribution for lighting and power.

Q. 3. How must an alternator be constructed to generate two-phase current?

A. 3. It must have two independent windings, and these must be so spaced out that when the E.M.F. generated in one of the two phases is at a maximum, the E.M.F. generated in the other is at zero, *i. e.*, they are 90 degrees apart, vectorially speaking.

SOLDERING QUERIES.

(810.) Paul Johnson, Poughkeepsie, N. Y., wants to know:

Q. 1. What is *hard solder?*

A. 1. An alloy composed of copper and zinc, or copper, zinc and silver. Hard

(*Continued on page* 213)

BACK TO THE DAYS OF VOLTA.

(*Continued from page* 172)

Volta was one of the most prolific inventors of all times. He invented a greater amount of basic electric apparatus than any other living scientist with the exception of Faraday. In Fig. 3, at the left is shown a clever apparatus which when energized by static electricity produces imitation hail. Fig. 3 (at right) shows his apparatus for exploding a mixture of oxygen and hydrogen by means of an electric spark.

LIGHTNING—HOW TO PROTECT YOURSELF FROM IT.

(*Continued from page* 175)

are *dry*. But let the hand be wet with water or with perspiration, or let the person stand on damp floor or ground, then enough current may pass thru the heart to paralyze it, and death will occur suddenly. Most fatalities from industrial currents come from those at 500 volts to 5,000 volts pressure. People who have received shocks from a 10,000 volt current have lived.

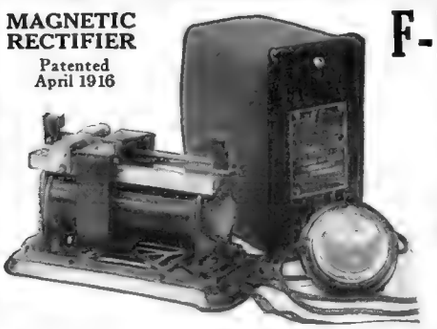
At low voltages the alternating current is three to four times as dangerous as the direct current, but at high voltages the direct current is the more dangerous. It is safe to pass a current at several hundred thousand volts pressure thru the body if there are over 10,000 alternations per second. Three-tenths of an ampere causes death at low rate of alternations but three amperes can safely be taken if the alternations are half a million per second. With wet hands and feet the resistance of the human body may be from 1,000 to 1,500 ohms. This is not much of a resistance for the lightning at its greatest pressure to overcome. A person standing isolated on moist soil makes an attractive target for the lightning.

There is a superstition that *lightning figures*, found on the skin of a person struck by lightning, are mysterious photographic reproductions of trees, landscapes or objects in the neighborhood at the time the person was struck. But the various figures produced doubtless show the distribution of the high potential electricity in passing along a poor conductor and the consequent burning along a ramifying path.

The telephone instruments and users to a large extent are protected by use of a device—*the lightning arrester*. This consists of a ground wire coming close to the telephone wire but not quite touching it. The gap between is enough to prevent the current used in telephoning from passing across to the ground, but when the wire receives a high charge from lightning, the potential is so high that the charge easily jumps across the gap and passes to the ground instead of passing thru the instrument and finding some other passage to the earth. You will observe that telephones properly installed in your homes are not placed where a person in using them could at the same time make contact with a register, radiator, or water-pipe.—"G. S. Q."

MAGNETIC RECTIFIER

Patented April 1916



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QUESTION BOX.

(*Continued from page* 212)

solder is sometimes erroneously called *spelter*.

Q. 2. What necessary relation must exist between solder and the metals with which it is to unite?

A. 2. The solder must have a lower melting point than the metals to be joined to it. The melting point should approach as nearly as possible that of the metals to be joined, so that a more tenacious joint is effected.

Q. 3. What does *soft solder* consist of and for what purpose is it best adapted?

A. 3. There are two classes of soft solders, viz., common or plumber's, and medium or fine. These consist chiefly of tin and lead, altho other metals are occasionally added to lower the melting point. Those containing the most lead are the cheapest and have the highest melting point. Common or plumber's solder consists of one part of tin or two parts of lead, and melts at 441° Fah. It is used by plumbers for ordinary work, and occasionally for electrical work where wiped joints are required; for instance, in large lead-covered cable work. Medium or fine solder consists of equal parts of tin and lead, or half and half, and melts at 370° Fah. This solder is used for soldering joints in copper conductors, and for soldering lead sleeves and lead-covered wires.

ELECTRO-THERAPEUTICS.

(811.) Thomas Holdstern, Little Creek, Mich., asks:

Q. 1. What is the true definition of the term "electro-therapeutics"?

A. 1. The term electro-therapeutics is defined as the treatment of disease by electricity; it embraces the laws, principles and doctrines of such treatment. Electricity is of special value in the treatment of various forms of nerve tension. The kinds of electricity used may be classed as follows:

1. So-called static, generated by Wimshurst machines.

2. Current, which is derived from two sources, namely, primary batteries, which current is technically called galvanic current and second the faradic currents (produced by secondary induction coils).

3. Radiant energy, which is generated by radio-active substances such as radium and radium ores, and X-rays. We may also add the curative powers of radiant energy generated by our distant sun.

Q. 2. What is meant by an interrupterless transformer as used in X-ray work?

A. 2. This is nothing more than a high-tension rectifier which converts the high-tension alternating current generated by the transformer into a uni-directional current which is fed to the X-ray tube. This rectifier is a four-electrode wheel rotating on the shaft of a synchronous motor, and the direct current is obtained from two fixt electrodes stationed near the revolving disc.

GOVERNMENT INSTALLS LAMPS TO PROTECT OHIO RIVER BRIDGES.

The Federal Government has purchased ten searchlights for use in illuminating approaches to the bridges over the Ohio River at Louisville, Ky., all of which are under guard. Another of the same lamps has been installed on the roof of the City Hall in Louisville and is used to illuminate the flag at night.

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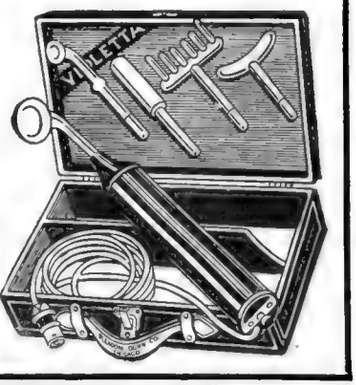

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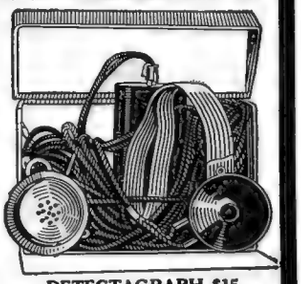

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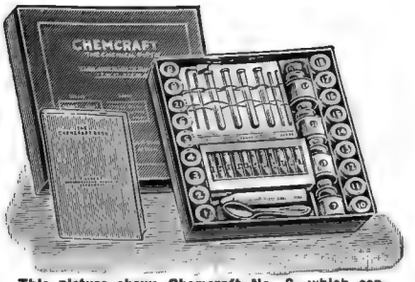

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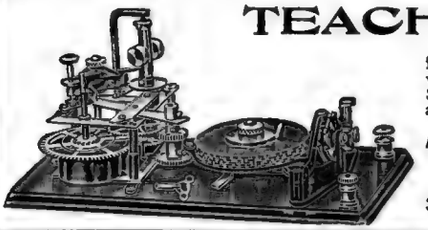

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THE U. S. SIGNAL CORPS WANTS YOU!

(*Continued from page* 179)

providing the men show ability and qualify."

The following information is publisht to answer, in general, inquiries regarding the Signal Enlisted Reserve Corps. The Enlisted Reserve Corps is authorized by section 55 of the National Defense Act, approved June 3, 1916, the purpose or object being to secure an additional reserve of enlisted men that could be brought to the aid of the Government in time of national crisis. Applicants must be citizens of the United States or have declared their intention to become such, and must be between the ages of 18 and 45 years.

The responsibilities assumed by men enlisted in the Reserve Corps are as follows:—They are subject, in time of peace, to duty in instruction camps or elsewhere, for fifteen days each year. They are subject to order to duty by the President whenever war is actual or imminent.

The benefits conferred are:—Opportunity to render their most effective service to their country in time of war; opportunity to prepare for that work beforehand by study and instruction; rank in the Army of the United States and corresponding pay while on duty; the right to wear a distinctive "rosette" or "knot" with *civilian* clothing.

Enlisted men of the Reserve Corps will be assembled in summer camps for fifteen days' instruction each year, so far as appropriations granted by Congress will permit. Transportation to and from these camps is furnished by the Government, also commutation of subsistence at the rate of 50 cents per meal during the journeys. While at the camps subsistence is furnished by the Government. Uniforms and equipment are also provided by the Government for use while attending the camps of instruction. Reservists are entitled to pay at the rate of their respective grades in the Regular Army during active service, including the time required for actual travel from their homes to the places to which ordered and return to their homes.

The grades and monthly pay of enlisted men of the Signal Reserve Corps, according to the new schedule, are as follows:—

Master signal electrician	$81.00
Sergeant, first class	51.00
Sergeant	44.00
Corporal	36.00
Horseshoer	38.00
Cook	38.00
Private, first class	33.00
Private	30.00

The following are the general qualifications requisite for enlistment in the Signal Enlisted Reserve Corps:

A. MASTER SIGNAL ELECTRICIAN. The applicant must be—

(a) An expert telegrapher and have knowledge of the construction, operation, and maintenance of telegraph systems, primary and secondary batteries, and motor generators, or—

(b) An expert radio operator and have knowledge of radio apparatus.

(c) Have knowledge of the construction, operation and maintenance of telephone systems, switchboards, location of troubles, repairs, primary and secondary batteries, motor generators, or—

(d) Possess such qualities as would fit him to act as senior non-commissioned officer of a company of Signal troops, to act as a leader.

B. SERGEANT, 1ST CLASS. The applicant must be—

(a) An expert telegrapher and have knowledge of the operation and maintenance of telegraph systems and batteries, or—

(b) An expert radio operator and have knowledge of radio apparatus, or—

(c) Have knowledge of telephone systems, switchboards, batteries, locating and correcting faults, etc., or—

(d) Possess such qualities as would fit him to act as leader of a platoon of a company of Signal troops.

C. SERGEANTS AND CORPORALS. The applicant must have general knowledge of the subjects given under B, or possess such qualities as would fit him to act as a leader of a platoon or section of a company of Signal troops.

D. PRIVATE, 1ST CLASS AND PRIVATE. The applicant must show an interest in the subjects mentioned, be competent, keen, and possess such qualities as will insure that he will develop along the proper lines in training.

Applicants for enlistment as Master Signal Electricians and Sergeants, First Class, will be given an oral examination. Applicants for enlistment in the other grades will demonstrate to the officer designated to obtain recruits that they have the necessary qualifications. Applicants for enlistment in the Eastern Department should present themselves at 39 Whitehall St. (near the Battery), New York City.

LOCATING AND DESTROYING SUBMARINES WITH A RED LIGHT RAY.

(*Continued from page* 165)

right angles to our course and she is thus in a position, broadside, to an observer from our vessel; that is, the submarine is presenting the greatest surface of her hull to us and is in the most favorable position for the visibility from our vessel, if she can be rendered so by any means.

A searchlight operated from aloft on our ship has two defects which prevent it from being sucessfully used for this purpose as a submarine detector.

A submarine ready to fire a torpedo is submerged to a depth of some fifteen or twenty feet. A searchlight played over the water from aloft must not only find the horizontal angle of the submarine but the vertical angle as well, the area being too great to admit accomplishment of this object.

Moreover, the ray of light when striking the water, passing from a light medium (air) to the denser medium of water causes a glare, due to the refraction which forms an opaque cloud to the observer, obscuring everything beyond it.

There is too much daylight for the searchlight to be practical during the day, the time when attacks are made by submarines.

However, if we submerge our searchlight or, rather, its ray of light to a depth of fifteen feet by installing the searchlight in the vessel at this depth below the waterline, and flash a powerful beam of light, *red in color* thru a thick lens of glass in the ship's side and out into the water, we obtain several distinct advantages over the searchlight operated from aloft.

It is only necessary to revolve this light thru an approximate angle of 90 degrees on either side of the vessel to bring a lurking submarine into its path, for the ray is already in the proper horizontal plane beneath the surface of the water.

It is operating only in one medium, water, and the opaque glow is not formed. Its color in contrast to the green sea enables it to be seen in bright daylight as a slender reddish path extending some *two miles* out into the ocean just beneath the surface of the water.

An observer with a powerful telescope is stationed aloft, whose duty it is to observe vigilantly this tract of crimson as it sweeps slowly back and forth abreast of the ship.

Suddenly he presses a button, instantly arresting the revolution of the beam of light, for he has noted that the ray of light does not extend to its ordinary limit, while there is a glare of blurred light forming what may be termed a "bulge" in its path and he realizes instantly that the beam of light has encountered a non-transparent body which is refracting the ray.

The alarm is sounded and the gun battery trained on the spot indicated. One or two shots will destroy the menace and the vessel may divert her course to clear it.

All that is necessary to insure the success of this method is the perfection of a searchlight of sufficient power and an experienced observer.

The public may confidently anticipate the rapid development of this system of defence, which will prove not only a mortal blow to the submarine but a benefaction to all humanity. The device here described is easily adaptable to either naval or commercial ships and a vessel may conveniently carry four search-lights of this type—two forward and two aft; one on either side of the hull in both positions.

DOES RADIANT LIGHT POSSESS WEIGHT?

(*Continued from page* 168)

mysteries. Briefly, he allowed a beam of light to fall on a suspended disc in a vacuum bulb, exhausted to the highest degree. In such a vacuum the disc was repelled on the impact of a light beam, and its repulsion was measured by its torsional effect on the suspending wire. This light-pressure at the distance of the earth from the sun is small, not quite a milligram per square metre of the earth's surface, or roughly, 70,000 *tons on the whole earth.* The light-pressure is applied only on the surface, and is proportional to the surface, while weight, or the pull of gravitation, affects the whole body. The adherents to the electro-magnetic wave theory of light have some difficulty in explaining this pressure, as it seems impossible to conceive of a mere wave-form in the ether exerting a material force or pressure on the earth. If light were considered a material substance, however, the above phenomenon could be more plausibly explained, as due to the effect of gravitation on a tangible substance.

There are many interesting facts to be obtained on the chemical and physical effects of light, and in respect to this side of the problem there are many opportunities for research work, which might result in the solution of the mystery as to the nature of light. Below are given a very few of the instances in which the elements are acted upon by the strange force of light: (1) Nitric acid is readily decomposed by light. (2) Silver chlorid, silver iodid and silver bromid are all chemically changed on exposure to light. (3) Silver nitrat in the presence of organic matter, looses its oxygen and is reduced to the metallic state by the action of light. (4) Mercuric oxid is decomposed by light. (5) The chlorids

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..Constipation	..Stoop Shoulders	Development
..Short Wind	..Deformity	..Great Strength
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and iodids of mercury and thallium are decomposed by light. (6) Upon heating nitrogen chlorid and nitrogen bromid in sunlight, the mixture explodes with violence. (7) A balloon containing hydrogen and chlorin will burst when exposed to the sun's rays. (8) Selenium lowers its electrical resistance when exposed to light. (9) In the Crooke's Radiometer the pressure of light causes a multi-blade vane or wheel to rotate in a vacuum.

It will be noticed in the cases cited above that the group of elements known as the *Halogens,* particularly the *silver salts,* are affected by the action of light, which acts in most instances like a reducing agent. Why the silver salts are singled out from all the other compounds and made an object of attack by the force of light is difficult to explain by the ether-wave theory. But if light were taken to be a gas, the above phenomenon would be more easily understood by the simple fact that light is then a reducing agent. The *light-gas* theory must thus assume that light possesses properties similar to other gases, such as chemical affinity, a definite valency, or possessing the power of a catalytic agent. Such properties appear to be consistent within the chemical effects of light as shown above.

As is well known, the element Selenium possesses the peculiar property of changing (lowering) its electrical resistance according to the intensity of the light cast upon it, and this strange phenomenon has been a strong argument against the wave theory, as it is almost impossible to conceive of the so-called ether waves producing such a tangible, material effect. Several theories have been advanced to explain this behavior of light. One is the formation of conducting selenids under the action of light. Another, the formation of conducting crystals. Still another, that it is due to electrolytic action and finally the electronic theory which assumes the releasing of negative electrons, due to vibratary resonance in the atoms.

Again, it has been demonstrated that light has a strong effect on bacteria, such as ferments. At the Paris Exhibition in 1900, the powerful results of light were forcefully illustrated by the culture of pathogenic bacteria in gelatin in glass bottles. Portions of the bottles were covered with dark paper, the bottles incubated at suitable temperatures in bright sun-light and the contents afterwards completely sterilized. Wherever the dark paper had prevented light action, dense colonies of bacteria could be seen, while in exposed parts the nutrient gelatin remained perfectly clear. Here again, light acts as a gas, for it can be easily shown that several gases such as oxygen, exert an influence on the growth of bacteria. Only a strong imagination could attribute these results to wave forms in the ether, it would seem.

In concluding, it may be well to take up the question of the speed of light and its relation to any of the accepted theories. The speed of light has been definitely accepted and proven as 186,000 miles per second, and this tremendous velocity has been for years a strong objection to the *corpuscular* or *material* theory, as it was unbelievable that any material form of matter could attain such terrific velocity. Of late years, however, there has been much progress made in the study and behavior of X-rays and radium emanations; and it has been conclusively proven by means of mathematics that the speed of the corpuscles emitted by metals under the impact of ultra-violet light, may be taken as anywhere from 10,000 *to* 90,000 *miles per second;* and it may also be stated that these corpuscles are *material* atoms of matter for their individual *weights* have been actually determined by mathematics.

In regards to the Alpha, Beta and Gamma-rays emitted by radium, it has been conclusively proven that the Alpha rays are streams of little bodies (matter) with a mass about twice the mass of the hydrogen atoms, flying off from radium with a velocity of 20,000 miles per second, while the Beta-rays given off by this innocent-looking little pinch of salt, are actual *material* corpuscles, with a known weight, and a speed of over 100,000 *miles per second.* This is now regarded as an established fact, and such being the truth, it is much easier to believe that a gas, such as light may be, could attain a velocity of 186,000 miles per second, and still be within the bounds of material matter.

As will be noticed, it was the author's object to present a few arguments in favor of the material theory, and altho this theory has not come into general acceptance by scientists, it is gradually gaining ground, and from the researches being made on radium emanations and all forms of radio-activity, it appears that the electro-magnetic-wave theory of light may have to be confined to more reasonable realms; it may well serve to explain wireless-telegraphy and such wave-activities, but the strange, material force known as "Light" certainly demands a more consistent explanation in view of its chemical effects.

U. S. BATTLESHIPS TO RUN ON LAND.

(*Continued from page* 170)

ner. The steering is equally simple and efficient. By running one motor at a slightly higher or lower speed, the ship must either turn to the right or to the left, as desired by its commander.

I have pointed out in previous articles, that the monster wheel is *the* prime requisite of all large war machines. A huge wheel, such as the ones here described, will easily ride over the widest trenches. Ordinary shell holes will be negotiated as easily as a cart wheel runs over a hole in the street due to a missing cobblestone. Rivers will be forded easily, if there is a fair approach. Even steep banks will be negotiated by running the craft diagonally thru the stream. Low hills will prove no obstacle at all, while steeper ones can be climbed by running the ship in a zig-zag line.

There will be less wear and tear, and less shocks too when running over land than when fording a tempestuous sea. The reason is that these huge wheels, just on account of their size, are rather elastic. They "give" a good deal. Then too, the earth as a rule is more or less soft. Thus we get a double spring action. Also due to the enormous width of the wheels—distributing the weight over a wide area—they will not sink into the softest earth much more than a few inches. This may seem surprising, but a simple calculation which any engineer may make in a few seconds, will prove the statement correct.

It goes without saying that in order to carry the enormous strain, the ship must be strengthened by a good deal of cross-truss steel work, as indicated in our illustration. Otherwise the shaft would rip clear thru the decks. This truss work, however, should not prove over difficult, nor a very long-winded operation. The reader has already guest that no new power plant is required. The old one is of course utilized, the ship burning coal the same as if it were on the ocean.

From a military standpoint, this monster engine of destruction proves rather interesting. But let us see what happens when the "Oregon," one fine summer morning steams thru the French fields, "Old Glory" flying from both masts, and plowing toward the German trenches. No more thrilling or awesome picture could be imagined. Of course long ere our battleship has reached the first trenches, the enemy aeroplanes have reported it, and the "Oregon" receives a warm welcome from the heavy enemy guns. But this is just what we want. After finding the range of the enemy guns, our battleship's 10-inch guns can either silence the enemy or otherwise run towards the German battery *and crush it by simply running over it.* There is no escape for them, for we have the advantage of quick mobility (the ship runs from 15 to 18 miles per hour) against the slow mobility of the enemy guns, which cannot be moved quickly. After annihilating these, the land monster runs amuck, destroying ammunition dumps, and raising general havoc behind the lines. Small guns and machine guns prove of little use against our armored battleships, and even if, as is to be expected, enemy shells find their mark, they cannot "sink" us or stop us. For the engines as well as all other vital parts are protected by heavy armor. The wheels themselves will not be put out of running order easily, because they are not solid. The shells, even if they do hit, will hardly destroy the entire wheel. Beyond ripping out a few steel beams, no great damage will be done.

The "Oregon" now runs over and parallel the trenches, the battleship's well protected machine guns emplaced low down in the holds, firing away continuously. The result is that the enemy must give way. If several battleships are used simultaneously in a grand attack, there is no question that the enemy must fall back over a wide area.

And it will be impossible for the enemy to board the swiftly moving vessel. Even if forced to stand still, its machine guns and other guns would ward off all close attacks.

There remains the aeroplanes dropping bombs into the ship. The answer here would be—anti-aeroplane guns, installed already on every modern war-ship. Besides our own aeroplanes would protect the ship by beating off the enemy flyers.

"HAM" JONES—SCIENTIST.

(*Continued from page* 181)

As we approached the curtain he spied a pair of pliers, and said, "By the way, you see how the cutting edges of these pliers are fused? Well, several days ago I cut a lamp cord with them. The current

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was on, and I cut both wires at once. There was some great fireworks, but those new fuses of mine held first rate." Then he laid them reverently upon the top of the helix.

"Hen" told me all about the mechanism of the curtain and then towed me back to the bed to show how he "turned in" and "hit the hay." It seems he did not use the curtain arrangement very often, for it had a habit of rising before the desired time; however, all was ready for the demonstration. "Hen" was supposed to have said his prayers and be snugly tucked under the covers.

"Watch out," he warned, "while I press button number one." So he prest it and with a click the latch gave away and the door swung open.

"Now for number two," cried "Hen." "Watch the curtain. This is the best of the whole bunch!" *Twang* went the spring of the curtain and up went the latter with a *bang,* but on its upward journey it struck the end of the pliers which "Hen" had left sticking over the edge of the helix; the pliers sailed over toward the 110-volt switchboard and thereupon there occurred a series of twangs and bangs intermingled with shooting stars and meteors—then something gave away and the Jones' house was plunged in total darkness!

"What the deuce!" cried "Hen", in alarm, and very undignified. "Wouldn't that make yer mad?"

From below, on the second floor, there came in a stentorian voice, a series of interrogations, ejaculations and commentations which only served to add terror to an already fluttering heart—so while "Ham" Jones hunted around in the dark for a ten-penny nail with which to form a 1918 model *Jones' Unblowable Fuse* (Patents Pending) I slunk down two flights of stairs and ran home as fast as I could.

AMATEUR AND EXPERIMENTAL RADIO RESEARCH.

(*Continued from page* 201)

Apparatus Necessary for Research Work.

While a well-equipt radio experimental laboratory is a great asset in research work; it is by no means an absolute necessity. By means of the ordinary amateur equipment, together with a few easily made accessories, one can do much experimental work of a very useful and penetrating nature. There are certain research problems, of course, that would demand elaborate apparatus to work with, but this is not generally true.

The amateur who wishes to do experimental work should equip his station with a certain amount of auxiliary apparatus. He should first wind several loading coils and inductances of various sizes. These coils should be labeled as to the number of turns they contain and the wave-length they should respond to (or better still, calculate or measure the inductance in centimeters of each coil as explained in the series by Secor and Cohen published in the March and April issues of this journal), as it is always best to know just what one is working with. Aside from these, several variometers of different sizes should be constructed, as they are almost indispensable in work of this nature. It is not necessary to build an elaborate cabinet for the variometers, as they can be placed inside a square framework, which is just as good. On each variometer there should be a single-pole switch, connected across the terminals so the instrument can be quickly eliminated from the circuit if desired. At least three receiving transformers should also be included in the equipment and these should be of various dimensions capable of responding to a wide range of wave lengths. It is also desirable to build several fixt receiving condensers of various capacities and each one equipt with a shorting switch. Detectors of various types should also be on hand, as it must be remembered that certain crystals are better adapted for some work than others. The Audion is not an absolute necessity unless it is desired to experiment with this particular instrument for regenerative work, etc. It might be said here that the Audion and its circuits offer a very fruitful line of research. At least three variable condensers should be included in an experimental outfit, as they are very necessary additions, absolutely essential for real serious work.

Probably the most important consideration in wireless research work, especially in regard to receiving, is the rapid change of connections. Experimental apparatus should be as flexible as possible. The simplest way to accomplish this is to build a small switch-board and this should contain a number of single point switches, D. P. S.T., D. P. D. T., and multipoint switches. The points and blades of the switches should be connected directly to binding posts on the back of the board. There should also be a row of binding posts fixt along the top of the board, as it is oftentimes found convenient as well as necessary to use such an arrangement.

The transmitting outfit should be equipt with several inductances, both loose and close coupled, of various dimensions and known values. A rotary, quenched and series spark gap, together with a large condenser with removable plates or other means of capacity variation should also be included. If experiments in radiation are to be conducted, it is of course necessary to either construct or purchase a reliable hot-wire ammeter. The problem of providing means for the rapid changing of connections in the transmitting apparatus is not as necessary as in the case of the receiving equipment. Furthermore, the connections are not so complicated. A few heavy switches may be added to the sending equipment, as they are found to be useful in many cases. Valuable research work can be carried on in the laboratory by means of a buzzer transmitter, together with a wave meter and a dummy or *loading antenna.* This is formed of a compact coil of resistance wire, designed to have the proper radiation resistance, inductance and capacity, and corresponding to a fair size antenna. These are available in the market and those interested will receive information concerning them by writing to the Editor, Radio Department, enclosing a stamped and addrest envelope. Most commercial radio transmitters are tested out today on a phantom aerial or load, as they are sometimes termed. See article elsewhere in this issue on the "load" or dummy antenna used by the Federal Telegraph Company. (See page 186.)

The suggestions offered above only deal with a general equipment for research work, and there will, of course, be many instances where the experimenter will have to use his own judgment in building instruments of special design to carry out his ideas. The only suggestion of worth that can be offered in this way is to work carefully and neatly, as results cannot be expected from a piece of apparatus that is "thrown" together. Altho it is not necessary to build elaborate experimental instruments, they should be neatly and substantially made, as it may be that a poorly constructed instrument may defeat an important and valuable experiment that would otherwise prove successful. Part II will take up "Suggestions for Research Work."

PATENT ADVICE

Edited by H. GERNSBACK

In this Department we publish such matter as is of interest to inventors and particularly to those who are in doubt as to certain Patent Phases. Regular inquiries addrest to "Patent Advice" cannot be answered by mail free of charge. Such inquiries are publisht here for the benefit of all readers. If the idea is thought to be of importance, we make it a rule not to divulge details, in order to protect the inventor as far as it is possible to do so.

Should advice be desired by mail a nominal charge of $1.00 is made for each question. Sketches and descriptions must be clear and explicit. Only one side of sheet should be written on.

THAT BELL SOFTENER.

(160) The Editor sometime ago in an Editorial entitled *"Inventions Wanted,"* mentioned that there existed a large market for an appliance which would take the disagreeable jar out of the telephone bell. This editorial was consequently publisht broadcast by dozens of newspapers and periodicals. Since then hundreds upon hundreds of letters reached the Editor's desk, nearly all the writers wishing to know who would buy such an invention.

Frankly, we do not know of any, offhand. Altho we are certain that if a really good appliance, which fills the bill, is invented, there are a number of electrical manufacturers and telephone manufacturers who certainly would want to buy the patent. But, like all good things, nothing sells itself. There was a positive demand for the telephone, long before it was invented, but everybody knows of the long, bitter fight that Bell had, trying to introduce his telephone. It is the same with almost any invention. After you make it, the fight to realize on it, begins. If you have something really good, you will make more money in the long run by marketing it yourself.

Another thing: When the Editor suggested the "Bell softener" he did not have some sort of a muffler in mind at all, as most correspondents seem to think. Muffling the gongs does not solve the problem. Take the gongs off and substitute *something* that is *not* a gong. Wooden or similar gongs won't do. Substitute rather something giving a *musical pleasing note,* soft and mellow, which however should not be harsh or abrupt. It is the abruptness of the telephone bell which gets on one's nerves.

MAGAZINE PENCIL.

(161) Morton Gross of Chicago has submitted to us an idea of a pencil which requires no sharpening. It is made of paper, but embodies a totally different construction than the present paper pencils on the market. Our advice is asked.

A. An extraordinary good idea, as good as it is novel. It also seems to us that it could be manufactured cheaper than the present patent ones. We feel certain that a good patent can be obtained.

OSCILLATING DEVICE.

(162) William Woodward, Wilmette, Ill., submits sketch, an illustration of a novel device for making a damped hookup oscillate. Is the device practical and can it be patented?

A. The scheme looks eminently promising on paper, but without necessary research work, we would not be willing to give a final opinion. We advise our correspondent to try it out by building a model. If it works, as described, a valuable patent will result. We have never seen anything just like it.

COVER LIFTING DEVICE.

(163) A. J. Walrath, Detroit, Mich., has sent us a description and illustration of a clever automatic cover lifting device attachable to garbage cans or ash cans. Is it patentable and practical?

A. A capital idea. Something that should appeal to every housekeeper and to every janitor. Moreover, the device can be manufactured very cheaply, and sold at a low price. We think it extremely practical and we believe a patent can be obtained upon the device.

INSULATOR.

(164) Harry J. Wright, Jr., North Vancouver, B. C., Canada, submits an insulator for outdoor wiring. This insulator uses two nails which are placed in such a manner that the insulator is not easily pulled away from its support during storms, or when sleet settles upon the wire.

A. A very good and a very cheap insulator. There is only one objection and that is that the insulator will crack when the nails are driven home, due to the fact that only one point of the nails touch the top of the insulator. If the top is made at an angle, so that the nails will meet the surface at right angles, a much better insulator will be the result. We think a patent can be obtained on the device.

NOVELTY FAN.

(165) Sidney Brown, Lake Charles, La., has submitted a design of a certain fan in which are incorporated novelty lights. Our advice is asked.

A. While the idea seems original and while a patent can probably be obtained, we think that the resulting flickering of the lights will be a serious objection unless the device is to be used only for advertising purposes, such as window display, etc.

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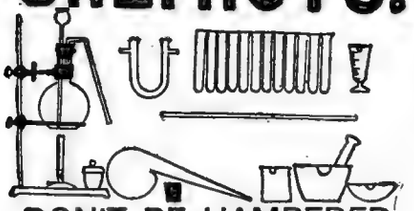

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EXPERIMENTAL CHEMISTRY.

(*Continued from page 203*)

Sodium Sulfate [$NaHSO_4$], is formed.

If two molecules of the salt are taken and one of Sulfuric acid, a less soluble salt, Normal Sodium Sulfate [Na_2SO_4] is formed, during which process a much higher temperature is required.

Hydrochloric acid can also be formed by the union of its constituent elements, namely, Hydrogen and Chlorin. When the gases, Hydrogen and Chlorin, are brought together in the dark, no action takes place. If the mixture is put in the sunlight, gradual combination takes place, and if the direct sunlight is allowed to fall for an instant, an explosion occurs, indicating the combination of the two gases. This sudden combination is also effected by the application of a flame, by a spark or by any intense light, as magnesium light, etc.

When water is formed by the combination of its constituent elements, hydrogen and oxygen, the introduction of an electric spark is necessary. This combination [Hydrogen and Oxygen] would not take place upon exposure to light. Thus we can see that Hydrogen and Oxygen can only combine to form water by introducing a spark, and not by exposure to light, while Hydrogen and Chlorin unite with explosive violence when any intense light is permitted to fall directly upon the mixture.

PROPERTIES:

Physical: 1. It is a colorless gas, possessing a sharp irritating and penetrating smell and taste, and produces suffocation when inhaled, and is poisonous.

2. It can easily be liquefied at 0° and 28 atmospheres, and solidifies at —111.1°. In the liquefied state it boils at —83.7°.

3. It is very easily soluble in water.

4. It is a little heavier than air.

5. When the fumes of the acid come in contact with moist air, dense white fumes are formed, and due to the great attraction of the gas for water, thus condenses the moisture. The fumes when the acid is brought into contact with Ammonia gas, are Ammonium Chlorid [NH_4Cl].

Commercial Hydrochloric acid [Also called Muriatic acid] generally consists of one-third acid to two-thirds water. This liquid if pure, should be without color. Sometimes it is of a yellow color, caused either by the presence of dissolved salts of iron or organic substances. The chemically pure [C. P.] should be without color. This may be distilled at 110°, when it gives a liquid containing 20% Hydrochloric acid, and corresponds to the formula, $HCl + 8H_2O$. If more Hydrochloric acid is contained in the liquid, heat will liberate the gas; if less, water will be liberated upon the application of heat.

CHEMICAL:

1. Hydrochloric acid possesses a very strong acid reaction.

2. It is not inflammable [a non-combustible gas], and does not support combustion, and is not decomposed by light or on heating; but its hydrogen may be replaced by metals as Zinc or Sodium, and its Chlorin by Manganese dioxid [MnO_2].

3. Sodium or Potassium burns vigorously in it on heating, forming chlorids.

4. It dissociates into its elements at 1800°.

5. It dissolves most metals, forming chlorids.

If there are two chlorids of a given

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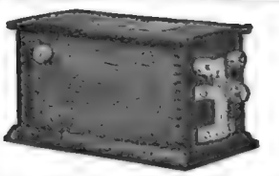

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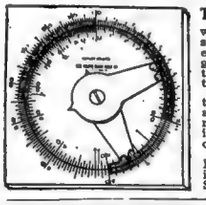

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metal, the lower is usually formed by Hydrochloric acid. Silver [Ag], Lead [Pb], Mercury [Hg], Copper [Cu], Platinum [Pt], Gold [Au], are not dissolved, or are very slightly acted on by this acid. Chlorids of the first three are insoluble; chlorids of the other three are formed by using Aqua Regia [Hydrochloric and Nitric acids].

USES:

1. It is used for preparing the chlorids of various metals.

As stated before, Sodium chlorid is the most important of the chlorids. Common Salt [Sodium Chlorid] besides its use as a preservative, is a necessary article of food with all animals living on vegetable diet. It is used in medicine, internally, in small doses as a gastric stimulant, in large doses as an emetic; externally in baths for the relief of rheumatism, and injected in solution, to replace loss of blood.

2. It is used for extracting phosphats from bones.

3. It is used in dyeing and tissue printing.

4. It is used in the manufacture of coal-tar colors.

5. It is used in preparing other compounds of chlorin than chlorids, and in preparing the element Chlorin itself.

6. In the laboratory it is used for generating hydrogen, also in analysis and in making Aqua Regia.

7. It furnishes chlorin, from which bleaching powder is made.

8. The silver chlorid [AgCl] in photography is deposited upon the photographic paper from solutions of Silver Nitrat [$AgNO_3$] and Sodium Chlorid [NaCl].

EXPERIMENT NO. 73:

Arrange a flask [about 250 cc.] with a two-hole rubber stopper and two bottles, each having a capacity of about 125 cc., make connections as shown in Fig. 69. The first bottle contains a three-hole rubber stopper thru which passes the delivery tube from the generator [the flask containing the Sodium Chlorid and Sulfuric acid], this tube should extend only a little below the stopper in both the flask and bottle, and should not touch the solution. A long glass tube is then inserted in the center hole of bottle No. 1 above the cork and below the surface of the water. This is called a *Safety tube*. A third tube just passes thru the stopper in bottle No. 1, and leads to the second bottle [which does not contain a cork] and in which the delivery tube is permitted to be under the water.

A *Wolff Bottle* (see Fig. 70) may be used in place of No. 1, and if this form is used, one containing three necks is to be preferred.

It will be noticed in the illustration of the apparatus that rubber connectors (cut diagonally—see Fig. 73) are used to connect the delivery tubes of the flask and second bottle. If it is desired, the tubing may be bent in one piece as shown, but it is more convenient to use separators, as the pieces may then be used in other experiments.

Fill the two bottles, 1 and 2, about one-quarter full of water. Set the flask on a ring stand support, on a piece of asbestos or wire gauze. Pour about 5 cc. of water into the flask and add 10 or 15 grams of sodium chlorid [common salt, NaCl], by pouring into the flask from a creased paper.

Have handy a splint, also an evaporating dish containing three or four drops of Ammonium Hydroxid [NH_4OH], and a stirring rod or piece of paper.

Make sure that all connections are air-tight, then pour about 20 cc. of Sulfuric acid [H_2SO_4] in small quantities, say three or four drops at a time, into the flask, by means of a *thistle* tube. Do not add too much acid at one time.

Action will probably take place upon the introduction of the acid, which is made apparent by the bubbling and frothing in the flask, but to aid it, a Bunsen flame should be placed under the flask. Do not apply too much heat, and if the liquid tends to pass over the delivery tube into the first bottle, remove the flame, and if it does not abate, add a little water thru the delivery tube.

The reactions which may take place, are:

1. $NaCl + H_2SO_4 = HCl + NaHSO_4$
   Sodium Chlorid — Sulfuric Acid — Hydrochloric Acid — Hydrogen Sodium Sulfate

2. $NaCl + 2H_2SO_4 = 2HCl + Na_2SO_4$
   Sodium Chlorid — Sulfuric Acid — Hydrochloric Acid — Sodium Sulfate

The equations are more fully explained in the preceding methods of preparation.

EXPERIMENT NO. 74:

Loosen the stopper of the flask and very cautiously try the odor of the fumes. Do not inhale too much, but just enough to give you the characteristic smell. [NOTE:—In case you have inhaled an overdose of the gas, an antidote should be taken, by inhaling the Ammonia from a bottle containing Ammonium Hydroxid].

Apply a lighted splint to the open mouth of the flask. The splint should go out, due to the fact that Hydrochloric acid gas is a non-supporter of combustion, and non-combustible.

Either bring the dish, glass rod or piece of paper dipt in the Ammonium Hydroxid to the mouth of the flask. Dense white fumes should be evolved upon the introduction of the Ammonia gas [obtained from the Ammonium Hydroxid] coming in contact with the Hydrochloric acid gas. This test is characteristic of the gas.

Look very closely at the liquid in the bottles 1 and 2 while the action is taking place in the flask. If you look thru the bottle at a strong light, it will be noticed that an oily liquid is being precipitated in these bottles. This is the Hydrochloric acid gas which is forming a solution with the water.

After about 10 or 15 minutes generating, remove the flame from under the flask. Allow to cool for a few minutes, then uncork the flask, insert a funnel, and cautiously pour in two or three test tubes full of water. The flask may then be filled from the jet and the contents poured out. If the substance in the flask has caked, be careful not to break the glass, but let it stand till cool before adding the water.

Save the liquid in the bottle No. 1 for the next experiment.

EXPERIMENT NO. 75:

Pour into a test tube about 5 cc. of the liquid obtained from bottle No. 1 in the preceding experiment, and into a second tube pour 5 cc. from the open bottle; then test each with litmus paper or solution. Determine if the solution is an acid by its action on litmus, as done in some of the experiments already performed.

To prove what is present we must apply tests for both the *positive* and the *negative* constituents of the compound.

EXPERIMENT NO. 76:

Pour about 5 cc. from bottle No. 1 into a small test tube and add two or three pieces of Zinc. After action has progrest for a short time, apply a lighted splint to the mouth of the tube to determine if a gas escapes. If we have Hydrochloric acid in bottle No. 1 it is reasonable to suppose that Hydrogen gas will be liberated when Zinc is treated with the liquid.

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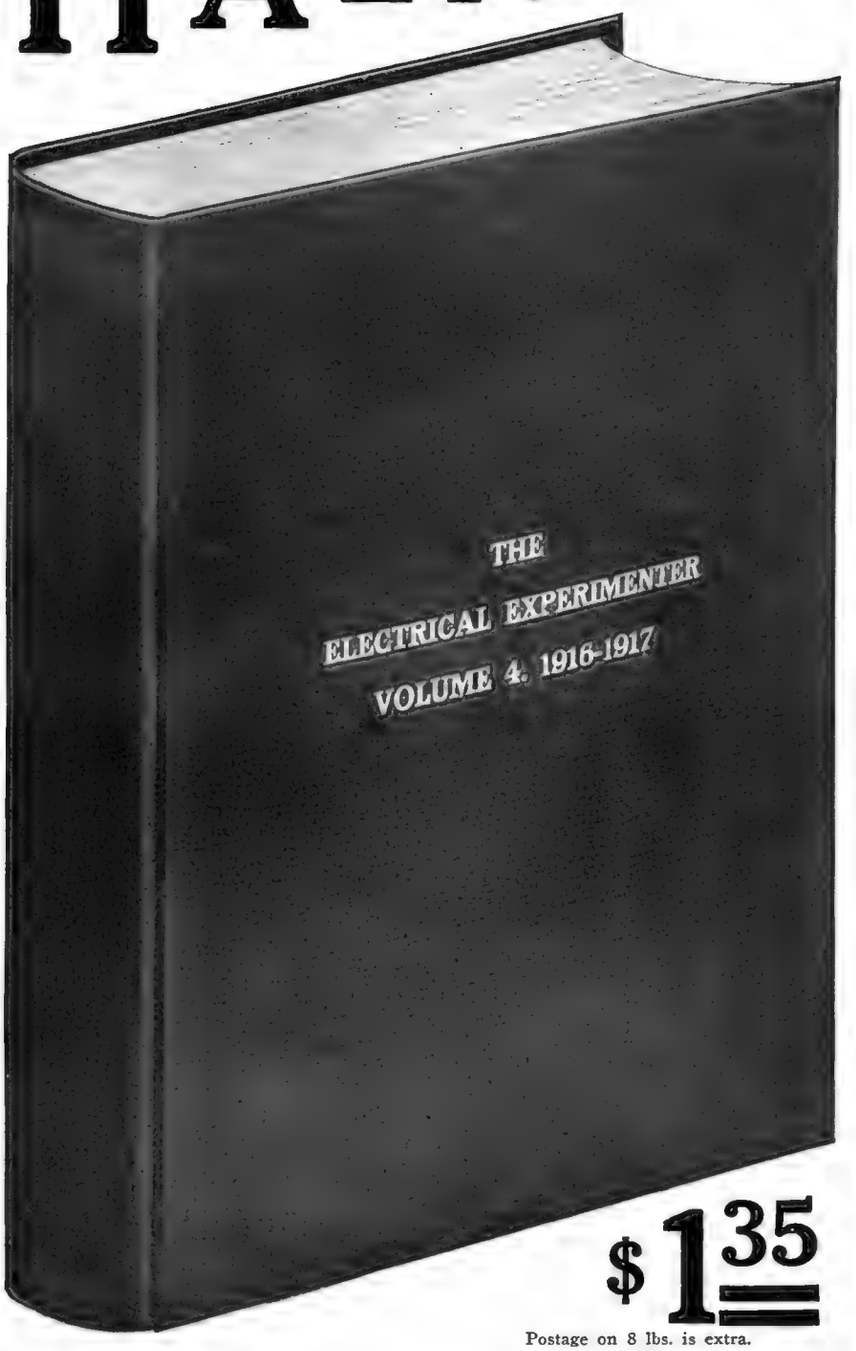

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EXPERIMENT NO. 77:

Pour small portions from bottle No. 1 into three tubes. To one add a few drops of Lead Nitrat solution, $[Pb[NO_3]_2]$, to another a few drops of Silver Nitrat solution, $[AgNO_3]$, to the third a few of Mercurous Nitrat solution $[HgNO_3]$.

White precipitates, the chlorids of the metals, Lead, Silver and Mercury, should form upon the mixture of the respective nitrats with Hydrochloric acid.

SOLUBLE CHLORIDS:

Soluble chlorids are made by dissolving in Hydrochloric acid, either a metal or some of its salts which are transposed by it.

INSOLUBLE CHLORIDS:

Insoluble chlorids may be made by adding Hydrochloric acid to solutions of the soluble salts of these metals, for example, Lead Nitrat $[Pb[NO_3]_2]$, Silver Nitrat $[AgNO_3]$, Mercurous Nitrat $[HgNO_3]$. There are only three chlorids, Lead Chlorid $[PbCl_2]$, Silver Chlorid [AgCl], Mercurous Chlorid [HgCl] insoluble in acidulated water.

SEPARATIONS:

Suppose we were to mix solutions of Lead Nitrat $[Pb[NO_3]_2]$, and Copper Nitrat $[Cu[NO_3]_2]$, the lead could be separated from the copper by Hydrochloric acid, for the former would precipitate and the latter remain in solution. On filtering, the lead would remain on the filter as a residue Lead Chlorid $[PbCl_2]$, and the copper would pass into the filtrat unchanged as Copper Nitrat $[Cu[NO_3]_2]$, or Copper Chlorid $[CuCl_2]$, and could be precipitated by Hydrogen Sulfide $[H_2S]$, as Copper Sulfide [CuS]. A mixture of Lead, Silver and Mercury salts could, by the same reagent, be separated from other salts in solution. This is exactly what is done in *Analysis.*

EXPERIMENT NO. 78:

Mix in a test tube about 5 cc. of Lead Nitrat solution, and an equal amount of Copper Nitrat solution. From the above explanation, see if you can devise a method of separating the lead from the copper in the solution.

EXPERIMENT NO. 79:

Pour about 20 cc. of Sulfuric acid [2 to 1] into a flask supported on an asbestos mat on a ring-stand, and add about 10 grams of Sodium chlorid [Common salt]. Gently rotate the flask so as to mix the acid with the chlorid. Close the flask with a two-hole stopper carrying a thistle tube and delivery tube arranged as shown, for the collection of gas by downward displacement in a *dry test tube.* If necessary heat the flask with a small flame. The contents of the flask will bubble and froth, indicating the process of liberating the gas (Fig. 74).

EXPERIMENT NO. 80:

Fill a dish with water and set it on the table. Take a test tube of gas collected [which is made apparent when the fumes are liberated in the air], close its mouth tightly with the thumb, invert the test tube, and hold its mouth below the surface of the water. Remove the thumb. Notice how the water acts with the gas.

EXPERIMENT NO. 81:

Close the mouth of the test tube with the thumb and remove it from the water. Moisten a piece of litmus paper with the liquid contained in the test tube. The result of change of the litmus would show that this effect is typical of the water solution of acids.

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July	"	"	"	Sept.	"	"	"
August	"	"	"	Oct.	"	"	"
Sept.	"	"	"	Nov.	"	"	"
Oct.	"	"	"	Dec.	"	"	"
Nov.	"	"	"	1917			
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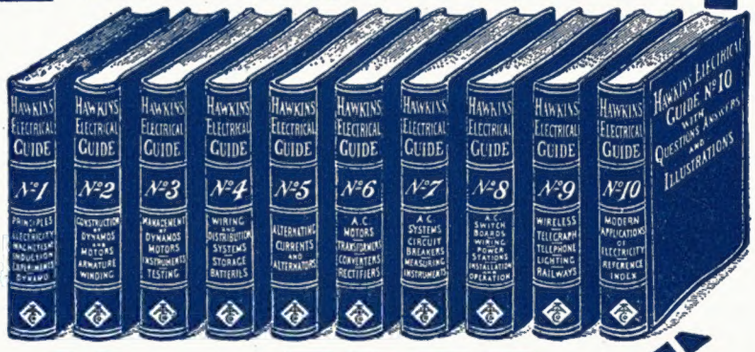

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